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AND NATURAL GASOLINE MANUFACTURER

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GRADY TRIPLETT
Editor

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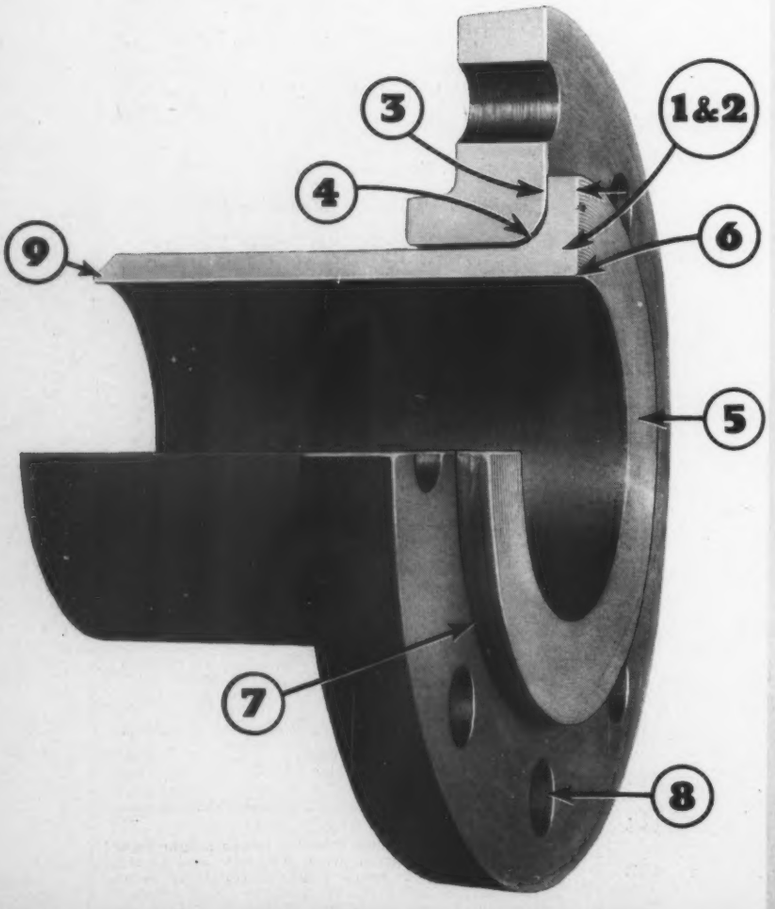

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REFINER
AND NATURAL GASOLINE MANUFACTURER

A GULF PUBLISHING COMPANY PUBLICATION

THE LOOK BOX

WHEN Ralph K. Davies, Deputy Petroleum Coordinator, appeared before the Oil Subcommittee of the Committee on Interstate and Foreign Commerce of the House of Representatives, May 26, he clearly stated a problem forced upon the refining industry and admitted that so far no solution has been worked out. The problem, turned into a question is this, how can a corporation continue solvent when it is limited in the price of its finished output while its costs continue upward?

When Prices Are Fixed

His testimony on this point was:

"In order to obtain greater volumes of fuel oil and lesser volumes of gasoline, the Government has found it necessary to direct that changes in normal refining practices be made which will accomplish a different yield of various products from a barrel of crude in certain areas. This, in effect, has meant for the refiner that he convert gasoline into fuel oil. The operating procedure is not quite so simple but the effect is precisely that. High valued products are debased and to this extent values are destroyed. In the course of the war, as conditions demand, there will doubtless be many adjustments of this kind called for and the economic effect thereof within the petroleum industry is bound to be severe.

"If the function of price in the economic scheme of things be eliminated, it would seem that something else must be found to take its place. Economic balances must be maintained and some substitute is necessary to establish the required equilibrium where price no longer performs this function. Here we have a problem of a very knotty sort and at the moment I have no specific proposal to advance. Many minds are at work upon the subject.

"Another consideration of importance in this connection demands attention. It is the tendency toward monoply, which must inevitably develop if dislocations within the industry of the kind I have referred to are not recognized and provided for in some manner. The effect is upon both large and small units in the business, and while there are limits beyond which even the largest and most powerful units can not continue in solvency, these limits are quite beyond those which apply in the case of the smaller and financially weaker units. The latter must consolidate with the former if they can, or fail completely if unable to recover their costs and protect their investment. Nothing makes for monoply in a more real way than economic disturbance over a period through which the smaller entities can not survive."

IF THE plant expansion for 100 octane aviation gasoline and ingredients for synthetic rubber were starting now, they would be combined. Along with them would go the units for toluol. This means that technology has advanced as it drew its plans. The units are now considered separate installations. Catalytic cracking, however, has advanced within a few months whereby units can be so operated that they will supply butane for dehydrogenation to butadiene, along

Already Obsolete

with a base stock for aviation gasoline, as well as selected feed for aromatization and finally toluol.

It is likely that some units will be built to permit adaptation of catalytic cracking as the center of the several processes for finishing critical war materials. Those already started will be completed as planned.

This all points to the day when the petroleum refinery will serve as the core of a chemical processing industry.

Stretching the Rubber Problem

TURMOIL of the rubber shortage is mindful of the empty cookie jar, with each boy pointing an accusing finger at the other. First one division of the federal government, by litigation and committee testimony, charged one of the larger oil companies not only with delaying the production of synthetic rubber but also with working in hand with the Axis. Although later testimony changed the complexion of the charges, many still believe there was guilt little short of treason.

Investigators within the legislative branch are charging that Rubber Reserve Corporation neglected to provide ample and possible stockpiles of natural rubber.

Now agriculture is charging petroleum with grabbing the synthetic rubber program and fending off the possibilities of farm products as raw material. Although no one has dared claim that agriculture can match petroleum in the speed of providing synthetic rubber, still the impression prevails that the farm needs only the go signal. Backers of Agriculture claim that the corn field is equally as ready as the oil field.

The man who burns garbage comes along with a claim of ingredients for 100 octane gasoline, synthetic rubber and toluol, perhaps methyl alcohol.

There are many sources of butadiene and styrene. The industry with sufficient raw material and the shortest time requirement for plant building offers the best source of providing synthetic rubber. From all that has been offered, it seems that petroleum best meets these requirements. Only on that score can the program be justified.

As for the charge that the petroleum industry has unfairly gained its position, it is a safe conclusion that the industry as a whole will subsidize any process that will keep 26,000,000 automobiles on the highways. The industry is that interested in profit. Such a subsidy, of course, would of necessity have to gain the approval of one or more branches of government. Profit has come to be somewhat of a horror character, even when it is a by-product of providing war materials.

This nation must have something to take the place of 700,000 long tons of natural rubber each year. If refining processes are part of the quickest route of accomplishment, it is time to halt the investigations and the accusations. Completion of the program is now too remote for comfort. Diversions will further lengthen the time.

From a scientific viewpoint ingredients for synthetic rubber may be had wherever and whenever a hydrocarbon molecule can be trapped. That is possible throughout so much of nature that the sources are limitless.

From a viewpoint of military expediency the hydrocarbon to take the place of the natural rubber molecule must be had from the quickest source. There is little question that petroleum is the quickest source.

A triangle now has come to take the place of a wheel in that politics has taken a place between the source of the hydrocarbon molecule and the quickest source of the molecule.

Reich Still Has Gasoline

AFTER studying fuel resources of Germany and the countries it has conquered, Charles Will Wright, foreign minerals specialist of the United States Bureau of Mines, comes to the conclusion that armies of the third Reich face no immediate shortage of gasoline and lubricants. His observation on this score in the publication, "Germany's New Mineral Position," is:

"Taking everything into consideration the German petroleum problem appears to be largely one of rationing and administration. With 78,000,000 barrels or more of petroleum and petroleum substitutes at its disposal and military needs and essential industrial needs given preference, Germany appears to be in no immediate danger of the failure of her military machine for lack of gasoline and lubricants.

"The occupation of the Near Eastern oil fields by Germany, which is still a possibility, would add to her current supply potential production of 192,000,000 barrels annually, or more than sufficient for all civilian and military needs. But the lack of facilities to transport this oil overland to Germany might deprive her of any real advantage of such occupation for some years. Any destruction wrought by the retiring troops, if they were forced to retreat, would be a further handicap to Germany in the exploitation of these oil fields even though permanent destruction of this oil supply can not be accomplished."

Role of Chromium in Steels For Cracking-Still Tubes

C. L. CLARK
The Timken Roller Bearing Company

DUE to the present scarcity of many of the alloying elements commonly added to steels to improve certain of their characteristics, considerable work has been, and is still being, done on possible substitutes. Programs are well under way on the development of substitutes for the structural grades of steels but the problem is more difficult with steels for heat- and corrosion-resistant applications. This is particularly true with steels for cracking-still-tube service for not only must they possess the desired degree of high-temperature strength but they must also withstand oxidation on the outside wall and corrosion on the inner surface.

While rigid restrictions are being imposed on the use of chromium in alloy steels, the addition of this element to steels for cracking-still-tube service is essential, mainly because the corrosion resistance to hot petroleum products is proportional to the amount of chromium present. Likewise, molybdenum must be added, for the straight-chromium steels are susceptible to temper embrittlement after service at elevated temperatures.

The severity of corrosion in different cracking units varies greatly, depending upon the particular crude used and to some extent upon the operating conditions. The grade of chromium steel required thus also varies, a higher chromium content being required the more corrosive the hot petroleum products. In order to meet these varying requirements, steels are available containing up to 9.0 percent chromium, as well as 18-8 and its several modifications for the most severe conditions.

While chromium additions are necessary for steels of this type, it is believed that appreciable economies could be obtained in its use if design of new equipment, as well as replacements for present installations, would be based on the estimated duration of the emergency rather than on an extended life of 10 years or so. For example, if in a given unit, 5 Cr Mo steel gives a life of 10 years then replacements for this unit, as well as proposed new units operating under the same conditions and on the same charging stock, could well be either of the 1.25 or 2.00 percent chromium type and a savings of more than 50 percent would result in the amount of chromium required. Likewise 18-8, in certain cases at least, could be replaced by the 7.0 or 9.0 percent chromium grades and a savings would result in both chromium and nickel. This procedure does, of course, require an estimate as to the duration of the present emergency but this is true to a certain degree in most of our war efforts.

Since many of the orders for cracking still tubes, and especially those for replacement and inventory, are of a relatively small order of magnitude, more rigid standardization of these steels is undoubtedly advisable in order to conserve melting capacity, and thus prevent the accumulation of overages in steel mills. At the present time there are 25 to 30 different analyses available for this type of service and all are believed to have their proper place during normal times. Under present conditions, however, and especially for the smaller orders, the number could probably be decreased to 10 or less.

Before the proper reduction can be made in the chromium content of a steel for a given application, it is necessary to know the effect of this change in composition on the surface stability and high-temperature strength. In order to assist in the evaluation of the characteristics of steels of this type, data are given in the following sections on the influence of chromium on these properties.

Corrosion Resistance

It is generally recognized that the resistance of steels to the attack of hot petroleum products is proportional to the chromium content. Too broad generalities are not permissible, however, especially from refinery to refinery, because slight differences in operating conditions and in the composition of the charging stock may influence the corrosion losses for a given type of steel.

If, however, the losses are expressed as a ratio to that of a given steel, then the results from different refineries are more readily comparable. This is illustrated in Figure 1, which gives the findings from three different refineries, based on their ratio to DM Steel (1.50 Cr, 0.75 Si, 0.50 Mo). Chromium content is the predominating factor, insofar as corrosion resistance is concerned, although increased silicon content or the addition of aluminum, does cause a further improvement.

Regardless of whether corrosion is considered on the basis of weight loss or penetration a fairly definite relationship exists between the corrosion resistance and the chromium content, even though the conditions in the three refineries were different. From these results it would appear that the 5 Cr type steels are five times as resistant as the 1.5 Cr steels; while the 7 Cr grades are twice as resistant as the 5.0; and the 9.0 is twice as resistant as the 7.0 Cr steels. Actual operating records from certain refineries substantiate these relationships which were developed from standard API strip corrosion specimens.

From this it follows that, insofar as corrosion

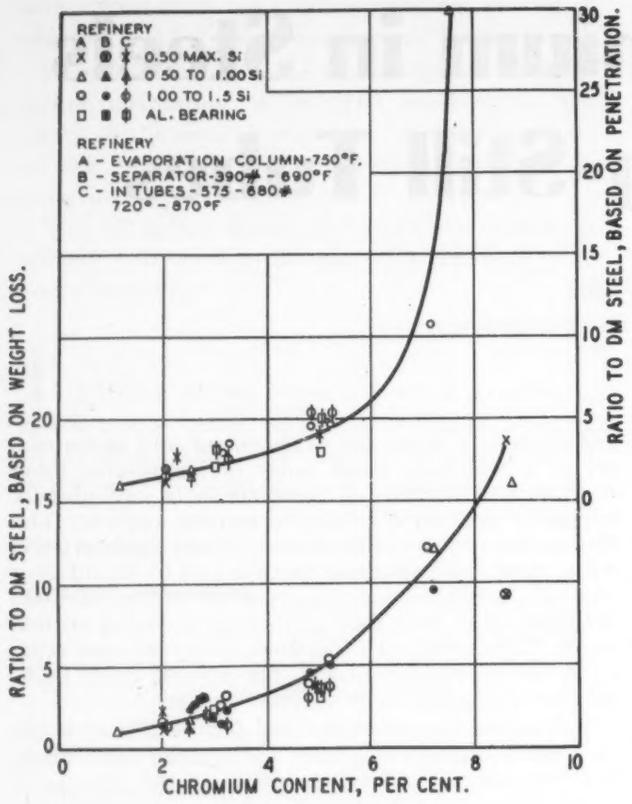

REFINERY
A B C
X 0.50 MAX. Si
Δ 0.50 TO 1.00 Si
O 1.00 TO 1.5 Si
□ AL. BEARING
REFINERY
A - EVAPORATION COLUMN-750°F.
B - SEPARATOR-390# - 690°F
C - IN TUBES - 575 - 680#
720° - 870°F
RATIO TO DM STEEL, BASED ON WEIGHT LOSS.
RATIO TO DM STEEL, BASED ON PENETRATION.
CHROMIUM CONTENT, PER CENT.

FIGURE 1
Comparative Corrosion Results From Three Refineries, Based on Ratio to DM Steel

resistance is concerned, a tentative guide, at least, exists for decreasing the chromium content if the steel now used is giving what is considered to be too long a life for present emergency conditions. In other words, if a 9.0 Cr steel is now lasting 10 years, a 7.0 Cr grade should have a life of about 5 years, and a 5 Cr steel about 2½ years.

Oxidation Resistance

Chromium content, by itself, is not overly effective in imparting a high degree of resistance to oxidation or scaling at temperatures of 1250 to 1500° F. unless it is present in amounts beyond 10.0 percent. The effect of chromium in this respect can be greatly improved by an increase in the silicon content, or by the addition of aluminum. This condition is shown in Figure 2. Whereas the straight 5 Cr Mo scaled excessively at temperatures in excess of 1250° F., an increase in the silicon content to either 1.0 or 1.5 percent, imparted good oxidation resistance even at temperatures up to 1500° F.

Insofar as the conservation of chromium is concerned, reductions can be made in the intermediate alloy steels without greatly changing the oxidation resistance. Any loss in scale resistance, due to a decrease in the chromium content, could be more than compensated for by an increase in the silicon. In fact available data indicate silicon to be 7 times as effective as chromium in imparting oxidation resistance to chromium-bearing steels.

Tube-wall loss, due to scaling, can also be reduced by a more careful control of combustion conditions and of furnace atmospheres. Too rigid restrictions on maximum tube-wall temperatures are not advisable, however, as this might decrease to an undue degree the operating cycle and thus interfere with production.

High-Temperature-Strength Characteristics

Chromium likewise has an influence on the high-temperature strength but it is not true that the strength is proportional to the chromium content. From this it follows that a decrease in the chromium content does not necessarily decrease the strength and in fact it may result in an improvement in this property.

There is not as yet general agreement as to the high-temperature-strength characteristics most suitable for design. Some use the creep resistance while others resort to the rupture strength. Insofar as cracking-still tubes are concerned, the stress-rupture characteristics are believed the most suitable for they not only afford a basis for design but also show the behavior of the steel under overheating conditions and give an indication of the degree of bulging or deformation to be expected prior to the rupture of the tube.[1]

Figure 3 shows the influence of chromium content, as well as molybdenum, on the creep strength (0.01 percent per 1000 hours) at 1100 and 1200° F. The steels containing 5.0 percent, or less, chromium are of normal silicon content, while the higher chromium steels contain 0.50 to 1.0 percent silicon. At both temperatures, the 2 to 5 percent chromium steels possess a higher creep strength than those containing greater or smaller amounts of this element. A decrease in the chromium content would not, there-

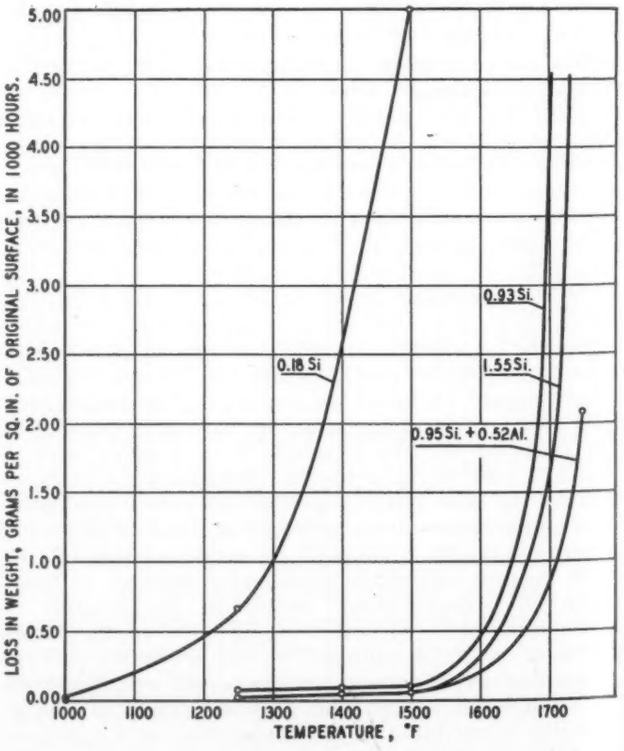


FIGURE 2
Influence of Silicon and Aluminum Additions on the Oxidation Resistance in Air of 4-6 Cr. Mo. Steel

[1] "High Temperature Strength Characteristics Available for Design of Cracking Still Tubes." Oil & Gas Journal, January 8, 1942.

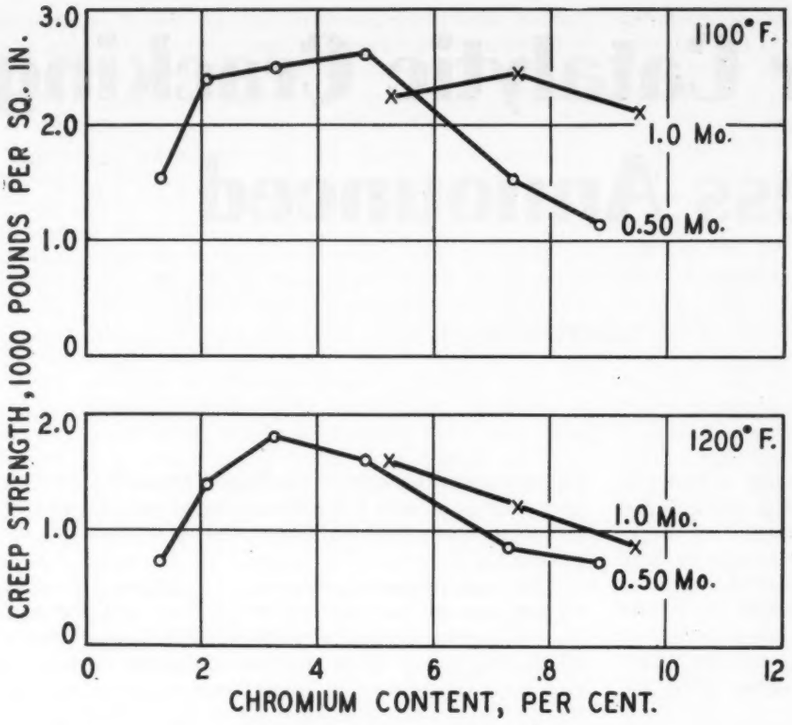


FIGURE 3

Left, Influence of Varying Chromium and Molybdenum Content on the Creep Strength (0.01%/1000 Hr.)

FIGURE 4

Below, Influence of Varying Chromium and Molybdenum Content on the Rupture Strength (100,000 Hr.)

fore, necessarily have a detrimental influence on the creep strength.

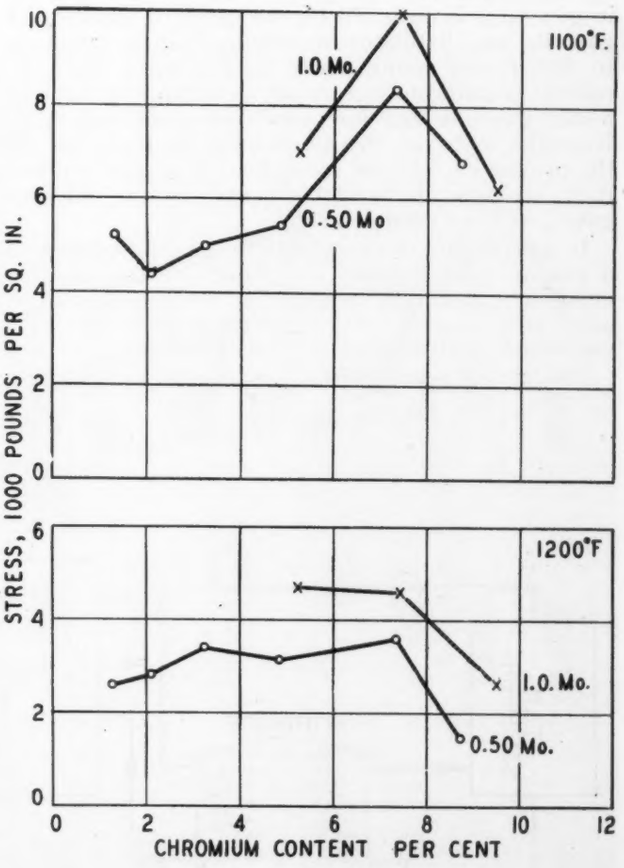
A similar comparison with respect to the 100,000-hour-rupture-strength values is given in Figure 4. At 1100° F. the rupture strength does increase with increasing chromium content up to 7.0 percent; while at 1200° F. the rupture strength is nearly constant as the chromium content varies from about 3.0 to 7.0 percent. Since the majority of tube failures occur at the higher temperatures, that is during overheating due to coke deposition, it would again appear that a decrease in the chromium content would not too greatly effect the life of the tube from the standpoint of the rupture strength.

Conclusions

While, in the majority of cases, chromium additions are necessary to steels for cracking still tube service, it is believed a conservation of chromium can result by:

1. Designing new equipment for the estimated duration of the present emergency rather than for an extended period of 10 years or more.
2. Making replacements in present operating units on the same basis as above.
3. For the smaller orders, that is those requiring less than a complete heat of steel, limiting the number of possible steels so as to prevent the accumulation of overages in steel mills and to conserve melting capacity.
4. For the larger orders, selecting the proper analysis so as to take full advantage of the known influence of certain other elements, such as silicon, or improving and supplementing the effect of chromium.

Such a procedure requires that more attention be given to the essential physical properties which, in the case of steels for cracking still service, are (1) surface stability, against the attack of hot petroleum products on the inner surface and combustion furnace gases on the outside wall, and (2) high-temperature strength. Data have been presented to show the influence of chromium content on each of these characteristics.



Thermofor Catalytic Cracking Process Announced

J. V. HIGHTOWER

A NEW system of catalytic cracking, called the Thermofor Catalytic Cracking (T.C.C.) process, is being offered to refiners for manufacture of high-octane gasoline, aromatics (including toluol) and butane-butylene gases used in production of synthetic rubbers and aviation alkylate. The process is of the continuous, countercurrent moving-catalyst-bed type of operation. A 20,000-barrel-per-day unit is under construction in a Texas refinery and other units are to be built.

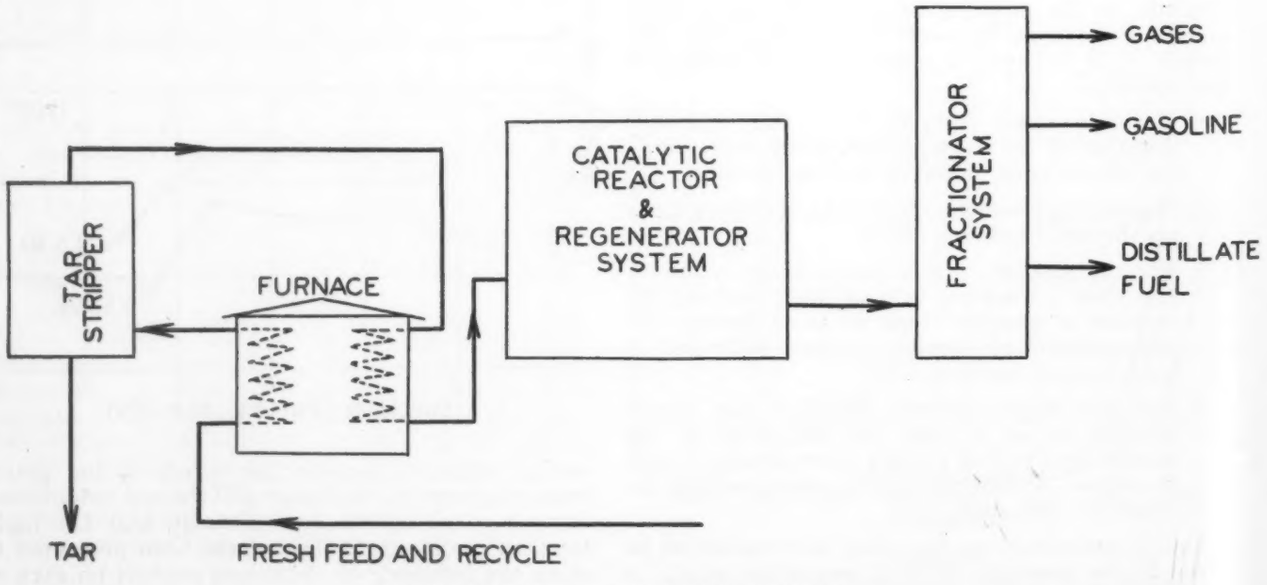
Few details about the process can be discussed but in general it is designed for the catalytic cracking of gas oils and distillates of varying boiling range up to 900° F. end point. Early developments were directed toward production of a maximum yield of motor gasoline and low yields of gases and coke. Recently, however, the process has been studied for the production of base stock for 100-octane aviation fuel, aromatic hydrocarbons and butane-butylene gases, with successful results.

In general the process involves the vaporization of a gas oil charge stock, the vapors then being discharged into a reactor chamber from which spent catalyst is continuously passing and into which regenerated catalyst is continuously entering.

Products of reaction, after leaving the catalyst bed, enter a separator where entrained catalyst is removed and then pass into a fractionating system from which gasoline, gas and distillate fuel are taken as final products.

The unit under construction is designed to charge 16,000 barrels per day of 21-gravity reduced crude. To this initial charge is added 10,000 barrels per day of cycle gas oil from the fractionating system, and the mixture enters a pipe furnace prior to being flashed into a low-pressure tar stripper. Heavy residual fuel oil leaves the bottom of the stripper. The stripper overhead vapors pass at the rate of 20,000 barrels per day through a vaporizing-superheating coil and then discharge into the reaction system. The unit is designed to produce either 300- or 400-end-point gasoline and a side stream of gas oil meeting No. 2 fuel specifications without further treatment. This is the outline of the operation, present circumstances preventing any disclosure of specific operating details such as temperatures and pressures.

A feature of the design is provision for generation of steam from waste heat developed on the unit. A total of between 52,000 and 65,000 pounds per hour of 450-pound steam and 5700 pounds per hour of 150-pound steam will be generated. Equipment for the installation consists of such ordinarily available



Generalized Flow Diagram of the T. C. C. Cracking Process

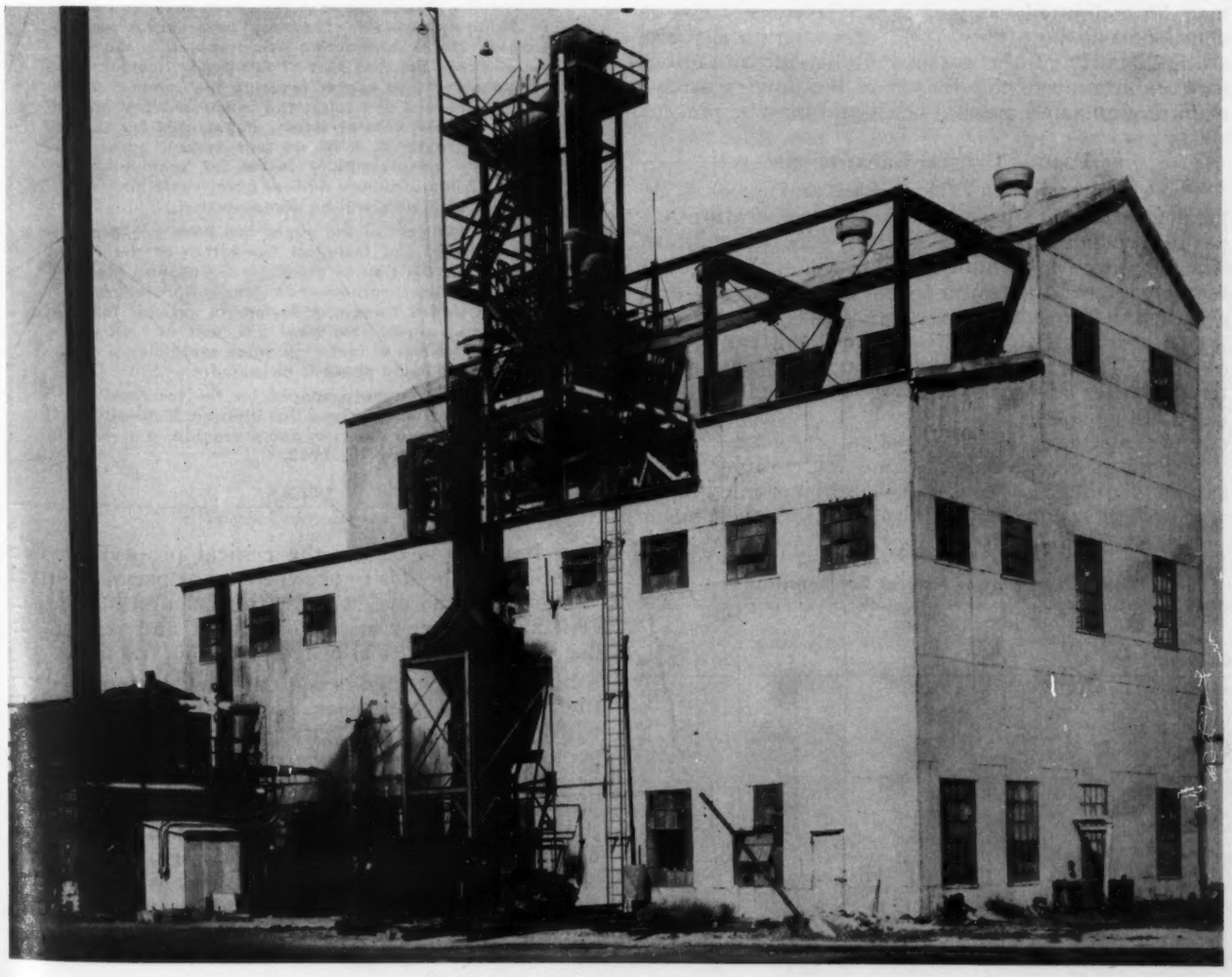
refinery materials as conventional structural forms, light steel plate, gray-iron castings, low-chrome and nonferrous alloy tubing, light steel sheets, pumps and the usual contol instruments. Four men per shift will run the unit.

Numerous experimental runs have been made in developing the process, utilizing both single-pass and recycle operations. In general it may be used (1) to produce a maximum yield of 400-end-point motor gasoline with high liquid recovery, (2) produce, at higher temperatures, a maximum yield of butane-butylene gases with a high percentage of butylene, (3) to make products at some intermediate condition. In single-pass operations, yields of between 35 and 45 percent of 400-end-point gasoline may be secured from distillates with end points as high as 900° F. In recycling operations using up to one part of recycle to one part of fresh feed, yields of from 50 to 60 percent of the same type of gasoline may be obtained. Recycling at higher temperatures may be employed in the production of a butane-butylene fraction where such a material is wanted for manufacture of synthetic rubber ingredient and aviation alkylate. The butane-butylene fraction ranges between 6 and 15 volume percent of the gas oil charge for normal operations and up to 20 or 25 percent for high-temperature operations.

Experimental work has recently been done in utilizing the process for production of base stock for aviation gasoline. The gasoline originally made by the process is vaporized and passed through a reactor containing the same type of catalyst used in cracking. The purpose of this step is to alter the nature of the 300-end-point fraction of the gasoline so that this fraction will have satisfactory acid heat, oxygen stability, lead susceptibility and gum characteristics. Experimental data show that this process produces a base stock of excellent quality. From 85 to 95 percent of the 300-end-point fraction present in the gasoline charged is recovered as aviation base stock. This stock contains high percentages of total aromatics and high percentages of toluol.

Investment costs of T.C.C. cracking units depend on the size of the units, nature of operating conditions selected and current prices of materials. Where existing thermal cracking units may be dismantled and their furnaces, fractionating equipment, pumps and other items used in a revamp job, the cost of a rebuilt installation, of course, is less than that of a new one. It has been pointed out that a new unit having a capacity of over 15,000 barrels per day of charge to the reactor represents an investment of less than $150 per barrel of charge.

The process was developed by Socony-Vacuum Oil Company from experiments in a semi-commercial plant. It is being licensed by Houdry Process Corporation through both The Lummus Company and E.. B. Badger & Sons Company.



Semi-Commercial T. C. C. Unit of Socony-Vacuum Oil Company

High Pressure Gas Measurement

PART I

The Density of Natural Gases

T. A. MATTHEWS and C. H. ROLAND, Phillips Petroleum Company
D. L. KATZ, University of Michigan

THE metering of natural gases through orifices under high pressure creates problems of two types. First, the calculation of the quantity of gas flowing through the meter requires the density of the gas. This usually involves a choice of the correct compressibility factor to account for its deviation from ideal gas laws. Second, the reduction in pressure accompanying flow of a natural gas at high pressure may cause liquid to be present from retrograde condensation. This liquid may interfere with uniform meter operation and must be included in the density of the gas flowing.

The reliability of the compressibility factor method for gas density calculations has been investigated in the Phillips Petroleum Company laboratories and a summary of this information was prepared in the summer of 1941. The first part of this paper is essentially an abstract of this report covering the comparison of the experimental and calculated compressibility factors on these eight natural gases, augmented by recent data from Texas A. & M. on four natural gases. The use of the compressibility factor for computing the density of high-pressure natural gases containing small quantities of liquids will be demonstrated.

The second part of the paper has been prepared at the request of the Technical Committee of the High-Pressure-Gas Division of the Natural Gasoline Association of America. It recommends standard procedures for obtaining orifice correction factors to account for the deviation of gases from ideal gas laws at high pressure. The problem of metering gases containing a small proportion of liquid phase is discussed.

These papers were prepared for the technical committee of the High-Pressure-Gas Division, Natural Gasoline Association of America, and presented at its annual meeting, Tulsa, May 15, 1942.

THE compressibility factor method has become well established as a means of computing the density of natural gases.[1,2] The importance of correct gas densities in such activities as metering and computing gas reserves under high pressure warrants added verifications of the reliability of the compressibility-factor chart for the large variety of the natural gases occurring in the natural-gas and natural-gasoline industry.

Natural gas under high pressure may contain small amounts of entrained liquid. The influence of this liquid upon the average density of the gas stream may be computed using data in the literature. Calculations will be presented to demonstrate the general reliability of the compressibility-factor method for computation of the density of the flowing stream even though small amounts of liquid may be present.

Pseudo Critical Calculations

The compressibility factor of natural gases is dependent upon the pseudo reduced temperature and pseudo reduced pressure of the gaseous mixture. These reduced conditions are the ratio of the absolute temperature and pressure to the pseudo critical temperature and pressure respectively. The pseudo critical temperature is the molal average critical temperature of the constituents in the gas mixture.[1,2,3] The critical temperatures and pressures recommended for these calculations are listed in Table I. Figure 1 is the compressibility factor chart for natural gases.[1,2]

For gases containing heptanes and heavier which can be identified by molecular weight, specific gravity and boiling range, the method of Smith & Watson[4] may be used to obtain the critical properties. The question of whether to use the true or pseudo critical temperature and pressure for this fraction may arise. It has been found more convenient and reliable to use the pseudo critical property of this fraction.[2]

TABLE I

Critical Properties of Natural Gas Constituents

Constituent	Critical Temperature, °R.	Critical Pressure Lb./Sq. In. Abs.
Air	238	546
Nitrogen	227	492
Oxygen	278	731
Carbon dioxide	548	1072
Hydrogen sulfide	673	1307
methane	344	673
ethane	550	712
propane	666	617
iso-butane	734	528
n-butane	766	551
butanes (Gulf Coast)	749	547
butanes (Mid-Continent)	744	546
i-pentane	830	483
n-pentane	846	485
pentanes	838	484
hexanes	908	443
heptanes (low content)	1010	430
(high content)	use mol. wt. and gravity with Fig. 2.	

Since boiling range is not customarily reported on the heptanes and heavier, plots have been prepared which give the pseudo critical temperature and pressure for heptane and heavier fractions of condensates or crude oils. The pseudo critical temperatures are based on a rough relationship between the slope of the distillation curve of a group of heptanes and heavier fractions in addition to Smith & Watson's charts. The pseudo critical pressures were fixed by the molecular weight and specific gravity. Figures 2a and 2b have been prepared based on specific gravity and °A.P.I. gravity for convenience.

Whenever the quantity of heptanes and heavier

TABLE II

Analyses of Gases for which Deviations Were Measured in Phillips Petroleum Company Laboratories

Constituent — Gas Indentification	MOL. PERCENT							
	No. 3	No. 6	C	E	F	H	N	O
Nitrogen	....	....	7.50	3.75	....	5.84	....	....
Methane	93.88	90.80	60.07	59.04	67.42	54.35	91.48	89.84
Ethane	3.59	4.23	14.77	20.37	16.75	16.32	3.71	5.07
Propane	1.22	1.98	13.42	14.03	15.84	16.20	2.47	2.51
i-butane	0.91	1.38	1.44	0.81	....	5.87	2.08	1.76
n-butane	....	....	2.37	1.76	....	....	....	....
Pentanes	0.30	0.63	0.43	0.24	....	0.91	0.26	0.62
Hexanes	0.10	0.43	....	....	....	0.18	....	0.14
Heptanes plus	....	0.55	....	....	....	....	....	0.08
Pseudo-critical temperature, °R.	361.1	372.7	426.6	444.2	429.5	451.3	369.4	374.1
Pseudo-critical pressure, lb./sq. in. abs.	670.2	668.3	652.1	649.1	670.7	647.9	694.2	669.8
Gas Gravity	0.6030	0.6550	0.8482	0.8439	0.7866	0.8870	0.6294	0.6447

are significant, the analysis should include the molecular weight and specific gravity of this fraction. If this information is available, Figure 2a or 2b will give the pseudo critical conditions by which the mol fraction of the heptane and heavier fraction is multiplied when computing the pseudo critical temperature and pressure of the mixture.

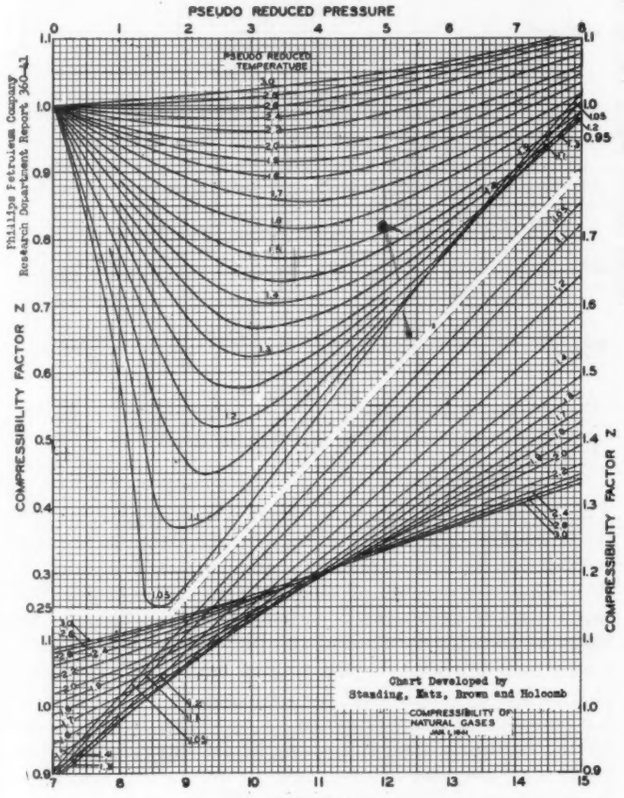


FIGURE 1
Pseudo Reduced Pressures

Experimental Compressibility Factors on Natural Gases

Data on the compressibility of eight natural gases have been taken in conjunction with equilibrium determinations[6] and metering problems. The apparatus consisted essentially of an equilibrium cell in a constant temperature bath connected to a volumetric mercury pump. Gas under pressure was placed in the cell and a series of pressure-volume measurements were made by increasing and decreasing the volume of the mercury in the cell. The pressures were observed with calibrated bourdon-tube gauges connected in the mercury line. The gas in the cell was expanded to atmospheric pressure for final measurement at which condition it was assumed to be an ideal gas. Table II lists the analyses of the eight gases which were examined at temperatures from 20° F. to 140° F. and at pressures to 5500 pounds per square inch. Table III lists the compressibility factors at 500-pound intervals for each isotherm investigated.

In addition to these new data, Prof. Vance of Texas A. & M. College submitted data to the N.G.A.A. Committee which Prof. A. B. Stevens and Mr. Lee Freidman had obtained on four natural gases.[7] This data was taken on a modified Burnett apparatus requiring only pressure measurements. Table IV gives the analyses of the four gases for which compressibilities were measured. Table V lists the compressibility factors at 500-pound intervals.

TABLE III

Comparison of Calculated and Experimental Compressibilities of Gases Determined in Phillips Research Laboratory

COMPRESSIBILITY FACTORS

Pressure Lb./Sq. In. Abs.	Gas No. 3 80° F. pT_R= 1.496		Gas No. 6 80° F. pT_R= 1.449		Gas No 6 40° F. pT_R= 1.342		Gas C 20° F. pT_R= 1.125		Gas C 80° F. pT_R= 1.266		Gas C 140° F. pT_R= 1.407		Gas E 20° F. pT_R= 1.095		Gas E 80° F. pT_R= 1.231		Gas E 140° F. pT_R= 1.370	
	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated
500	0.935	0.923	0.921	0.916	.....	.....	0.737	0.791*	0.845	0.866	0.904	0.907	0.641	0.756*	0.803	0.854*	0.880	0.894
1000	0.874	0.861	0.843	0.840	.....	.....	0.559	0.508*	0.700	0.732*	0.813	0.817	0.477	0.400*	0.638	0.690*	0.753	0.796*
1500	0.822	0.809	0.776	0.778	.....	.....	0.438	0.422*	0.603	0.628*	0.741	0.742	.....	.....	.....	.....	0.651	0.718*
2000	0.790	0.777	0.738	0.744	.....	.....	0.489	0.472*	0.586	0.612*	0.707	0.710	.....	.....	.....	.....	0.631	0.684*
2500	.....	.....	0.741	0.742	.....	.....	0.566	0.557	0.620	0.632	0.715	0.712	.....	.....	.....	.....	0.657	0.690*
3000	.....	.....	0.763	0.760	.....	.....	0.645	0.636	0.677	0.684	0.745	0.743	.....	.....	.....	.....	0.706	0.718
3500	.....	.....	0.798	0.797	0.757	0.752	0.723	0.719	0.738	0.742	0.788	0.786	.....	.....	.....	.....	0.762	0.768
4000	.....	.....	0.847	0.840	.....	.....	0.802	0.800	0.803	0.810	0.837	0.840	.....	.....	.....	.....	0.825	0.822
4500	.....	.....	0.898	0.891	.....	.....	0.882	0.885	0.869	0.880	0.892	0.895	.....	.....	.....	.....	0.888	0.880
5000	.....	.....	0.946	0.946	.....	.....	0.962	0.965	0.934	0.952	0.949	0.956	.....	.....	.....	.....	0.957	0.941
5500	.....	.....	0.998	1.001	.....	.....	.....	.....	1.000	1.022	1.007	1.013	.....	.....	.....	.....	.....	.....
6000	.....	.....	1.051	1.060	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[*Continued on page 60*]

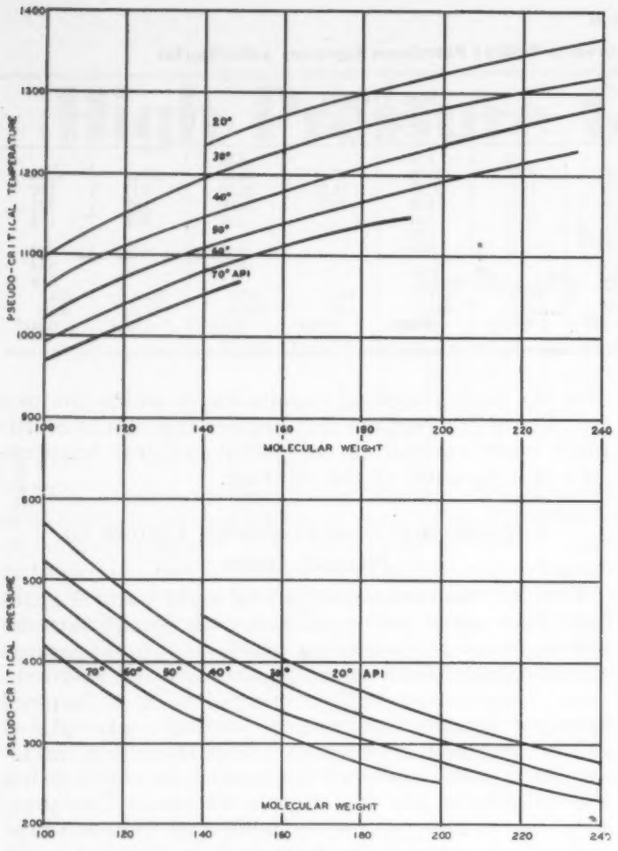


FIGURE 2a

Pseudo Critical Pressures and Temperatures for Heptanes and Heavier

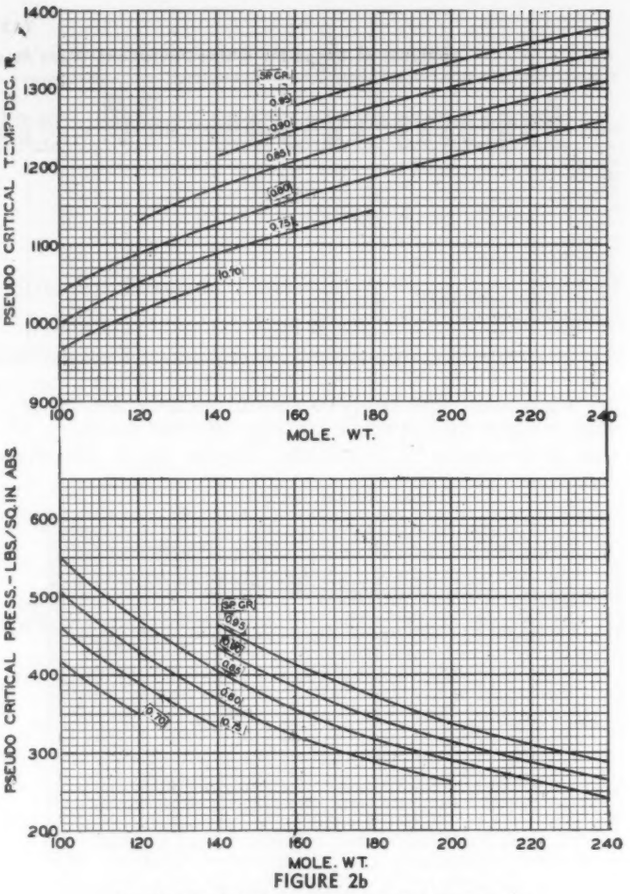


FIGURE 2b

Pseudo Critical Temperatures and Pressures for Heptanes and Heavier (Specific Gravity)

Comparison of Experimental and Calculated Compressibility Factors for Natural Gases

The compressibility factor plot extended to a reduced pressure of 15 or to about 10,000 pounds per square inch has been shown to be reliable based on the data previously available.[2] Over the pressure range of atmospheric to 3000 pounds, the plot was based primarily on data published by Sage, Lacey and co-workers.[5] The reliability of this chart was demonstrated by comparing it with the data available at that time. Table VI gives a comparison of compressibility factors for 16 gases in equilibrium with crude oils at pressures up to 8200 pounds. This data was used to extend and correct the chart above about 3000 pounds.

The experimental data on the 12 natural gases of Tables II and IV are compared with the values read from Figure 1 at the corresponding pseudo reduced temperatures and pressures in Tables III and V. A casual inspection of the experimental and calculated values indicates a substantial discrepancy for some of the gases at low temperatures and at pressures to 2000 pounds per square inch. Figure 3 is a plot of the experimental data for gas H and is typical for the higher gravity gases. The sharp break in the 30° F. isotherm and the straight line at higher pressures can only be interpreted as indicating complete liquefaction at 1600 pounds and 30° F. At lower pressures at 30° F. as well as at some pressures on the 80° F. isotherm, two phases probably were present

TABLE III (Continued)

Comparison of Calculated and Experimental Compressibilities of Gases Determined in Phillips Research Laboratory

COMPRESSIBILITY FACTORS

Gas F 80° F. pT_R= 1.257		Gas F 140° F. pT_R= 1.397		Gas H 30° F. pT_R= 1.103		Gas H 80° F. pT_R= 1.215		Gas H 140° F. pT_R= 1.350		Gas N 60° F. pT_R= 1.408		Gas N 100° F. pT_R= 1.516		Gas O 60° F. pT_R= 1.390		Gas O 100° F. pT_R= 1.497	
Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated
0.850	0.862	0.906	0.906	0.710	0.785*	0.822	0.851*	0.889	0.897	0.909	0.912	0.931	0.931	0.901	0.901	0.923	0.925
0.704	0.720	0.818	0.816	0.532	0.410*	0.651	0.655*	0.774	0.782	0.820	0.828	0.864	0.870	0.805	0.815	0.852	0.861
0.600	0.607	0.743	0.744	0.423	0.383*	0.537	0.535	0.688	0.704	0.750	0.759	0.809	0.820	0.734	0.739	0.797	0.807
0.578	0.586	0.708	0.796	0.476	0.452*	0.543	0.542	0.660	0.666	0.712	0.719	0.784	0.788	0.696	0.701	0.767	0.775
0.616	0.616	0.714	0.708	0.557	0.543	0.598	0.598	0.679	0.678	0.712	0.711	0.783	0.775	0.697	0.703	0.763	0.772
0.670	0.664	0.743	0.732	0.640	0.632	0.668	0.663	0.723	0.714	0.740	0.733	0.790	0.790	0.728	0.728	0.779	0.790
0.732	0.727	0.784	0.772	0.722	0.716	0.738	0.732	0.774	0.765	0.780	0.768	0.828	0.818	0.771	0.770	0.806	0.820
0.794	0.792	0.834	0.825	0.803	0.802	0.808	0.794	0.832	0.827	0.828	0.813	0.864	0.855	0.818	0.824	0.844	0.860
0.862	0.862	0.889	0.880	0.886	0.890	0.880	0.887	0.893	0.892	0.881	0.867	0.906	0.893	0.870	0.880	0.887	0.905
0.928	0.931	0.941	0.936	0.968	0.973	0.951	0.960	0.958	0.955	0.937	0.921	0.951	0.940	0.924	0.938	0.932	0.953
1.000	1.000	1.011	0.997	.....	.....	.....	.....	.....	.....	0.991	0.977	0.997	0.988	0.976	0.997	0.981	1.005

* Liquid phase may be present.

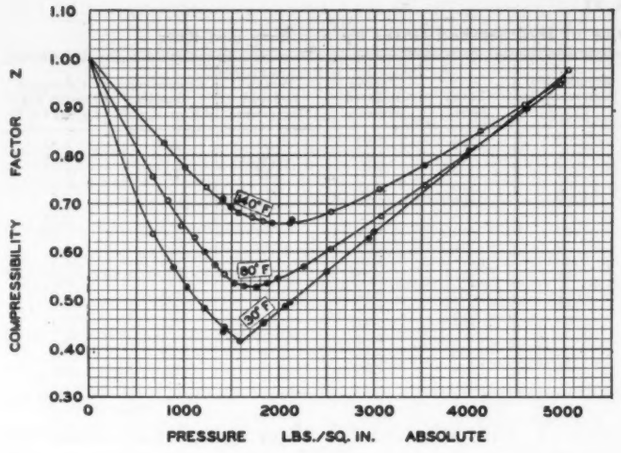


FIGURE 3

Compressibility Factors for Gas H.

TABLE IV

Analyses of Gases for which Deviations were Measured by Prof. Stevens and Mr. Freidman

Gas Indentification	Mol. Percent A	B	C	D
Nitrogen	0.81	.....	.....	.....
Carbon dioxide	1.80	.....	0.61	0.4
Methane	84.99	94.63	85.00	94.32
Ethane	6.64	2.54	6.00	3.90
Propane	2.67	1.46	3.32	1.17
i-butane	1.07	0.46	0.85	0.08
n-butane	0.91	0.38	1.29	0.13
i-pentane	0.82	0.36	0.66	.....
n-pentane	.....	.....	0.56	.....
Hexanes	0.19	0.17	1.09	.....
Heptanes plus	0.10	.....	0.62	.....
$^{p}T_c$ °R	374	360	393	358
$^{p}P_c$ lb./sq. in. abs.	658	670	664	675
Gas Gravity	0.686	0.605	0.721	0.591

in the equilibrium cell. Accordingly the low temperature and relatively low pressure values at which liquid was likely to be present were marked with an asterisk on all gases.

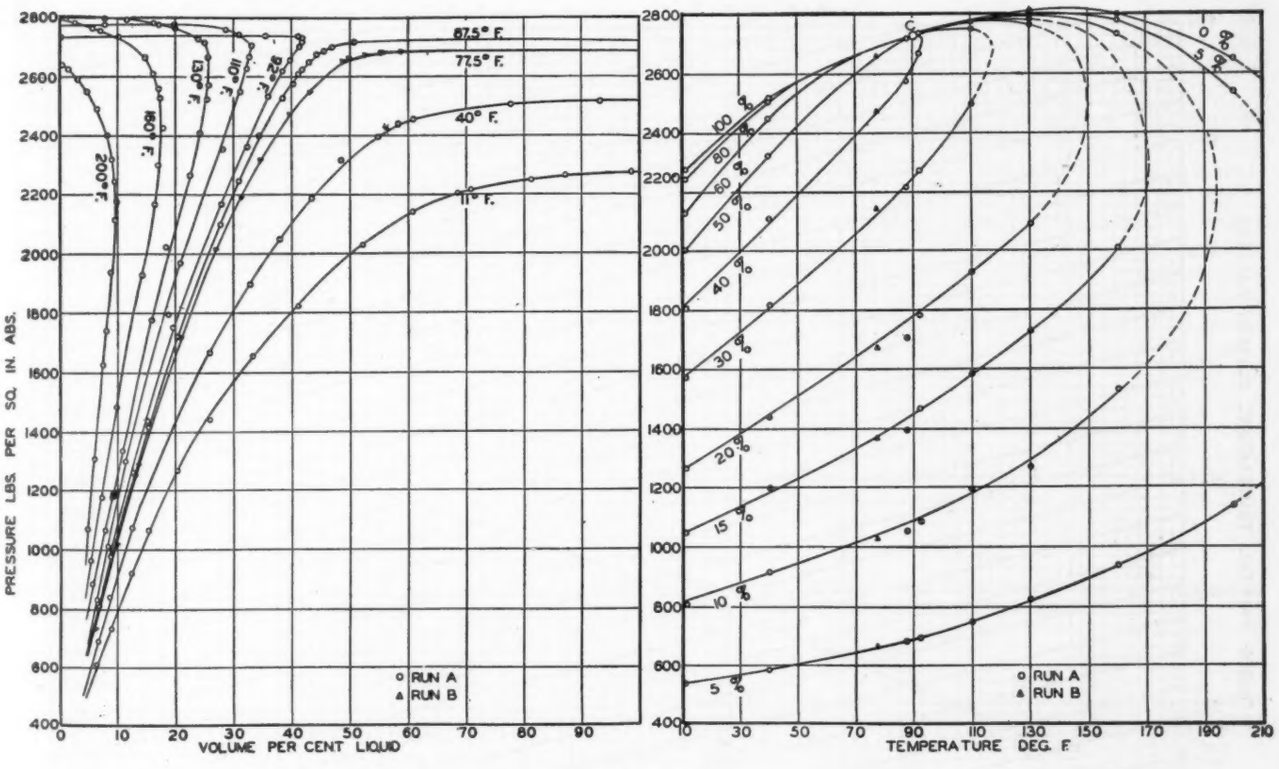


FIGURE 4

Phase Relations of a Natural Gas-Natural Gasoline Mixture

TABLE V

Comparison of Calculated and Experimental Compressibilities of Gases Determined by Stevens and Freidman at Texas A. and M.

COMPRESSIBILITY FACTORS

Pressure Lb./Sq. In. Abs.	Gas A 200.7° F. T_R=1.77		Gas A 113.4° F. T_R=1.53		Gas A 88.3° F. T_R=1.46		Gas B 150° F. T_R=1.70		Gas B 110° F. T_R=1.58		Gas B 85° F. T_R=1.52	
	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated
500	0.960	0.960	0.925	0.929	0.902	0.915	0.954	0.954	0.940	0.937	0.929	0.929
1000	.927	.928	.862	.865	.823	.844	.913	.915	.889	.885	.869	.868
1500	.900	.901	.811	.821	.756	.785	8.79	.884	.845	.842	.819	.814
2000	.884	.887	.775	.788	.725	.749	.867	.874	.823	.820	.789	.787
2500	.882	.880	.772	.787	.728	.749	.870	.855	.822	.806	.787	.782
3000	.891	.893	.797	.802	.755	.771	.881	.863	.834	.822	.802	.799
3500	.910	.912	.821	.837	.787	.807	.898	.887	.854	.848	.827	.825

[*Continued on page 62*]

TABLE VI

Comparison of Experimental and Calculated Densities of Hydrocarbon Gases by Standing and Katz

Run No.	Pressure, Lb./Sq. In. Abs.	Temperature, °F.	Experimental Compressibility Factor	Gravity Air=1	Pseudo Reduced Pressure	Pseudo Reduced Temperature	Experimental Density Lb. per Cu. Ft.	Calculated Density Fig. 1 Lb. per Cu. Ft.
A-5	1,000	120	.870	.659	1.50	1.55	3.52	3.50
A-41	1,600	120	.826	.671	2.42	1.54	6.06	6.12
A-1	3,185	120	.810	.766	4.87	1.47	14.0	14.4
A-2	5,270	120	.970	.840	8.09	1.41	21.2	20.8
A-3	8,220	120	1.358	.899	12.7	1.37	25.2	25.2
B-1	2,920	250	.884	.766	4.44	1.77	9.61	9.55
C-2	1,010	120	.852	.629	1.50	1.59	3.47	3.31
C-1	2,880	120	.777	.736	4.35	1.48	12.7	12.7
C-31	5,330	120	1.031	1.04	8.36	1.29	25.0	25.5
D-1	4,330	120	.865	.876	6.70	1.37	20.4	20.2
E-1	4,195	120	.879	.736	6.34	1.48	16.3	16.3
F-1	3,185	250	.925	.915	4.90	1.69	12.0	12.8
F-2	4,310	250	.931	.985	6.72	1.60	17.3	17.3
F-3	5,530	250	1.031	1.07	8.72	1.55	21.8	21.6
G-2	3,485	35	.737	.926	5.41	1.14	23.9	24.2
G-3	4,970	35	1.008	1.074	7.86	1.08	28.9	28.6

Enough data are now available to gather some statistics on the accuracy of the compressibility factor plot as compared with the data. Table VII is a summary of the errors for comparisons in Tables III, V and VI, and for those previously reported[2] on the Rio Bravo gas.[8] The temperature range represented by these data is from 20° F. to 280° F. The pressure range is atmospheric to 8220 pounds. The

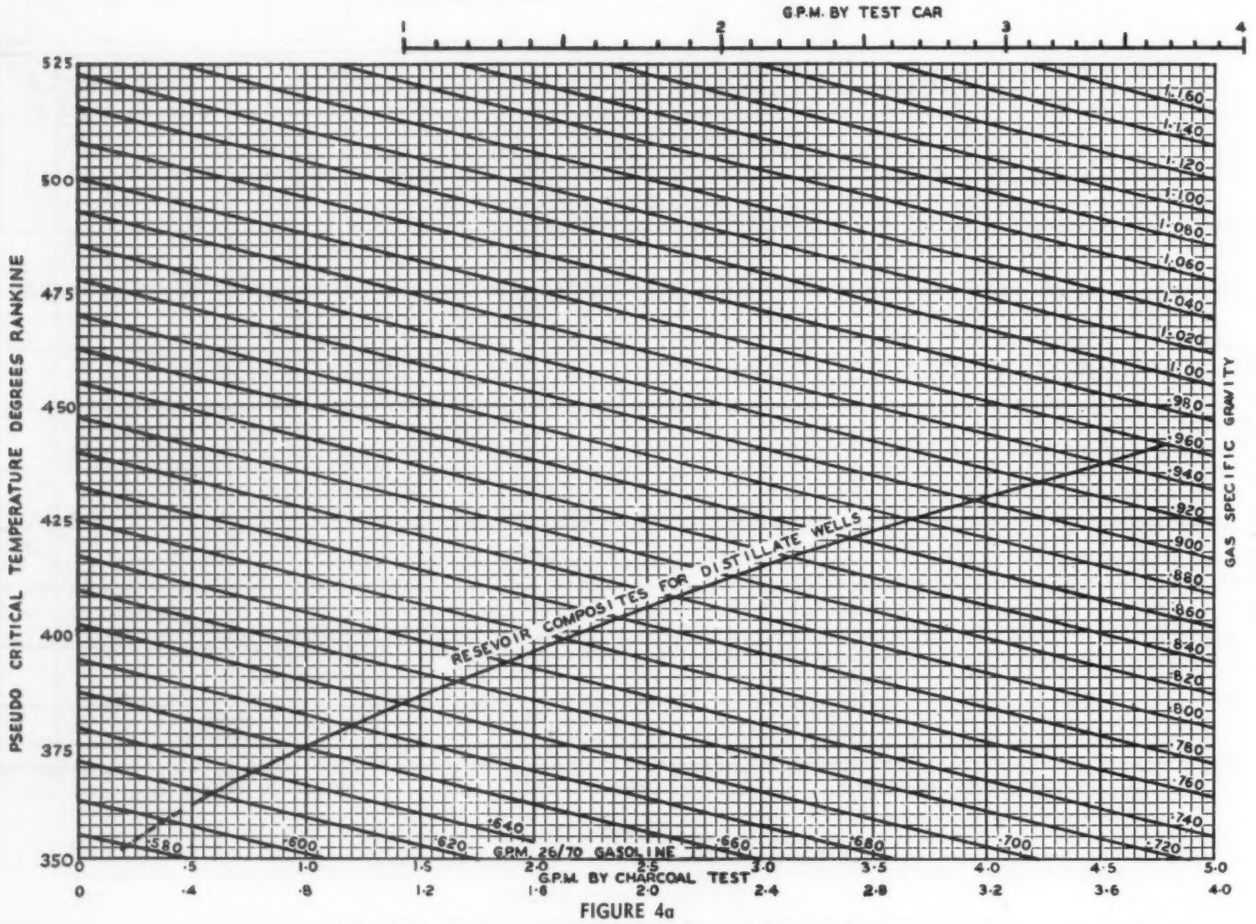


FIGURE 4a

Pseudo Temperature as a Function of Gas and Gasoline Content

TABLE V (Continued)

Comparison of Calculated and Experimental Compressibilities of Gases Determined by Stevens and Freidman at Texas A. and M.

COMPRESSIBILITY FACTORS

Gas C 199.7° F. T_R=1.68		Gas C 152.4° F. T_R=1.56		Gas C 81° F. T_R=1.38		Gas D 150° F. T_R=1.71		Gas D 110° F. T_R=1.60		Gas D 90.6° F. T_R=1.54	
Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated
0.960	0.951	0.947	0.935	0.918	0.899	0.958	0.956	0.939	0.940	0.929	0.934
.929	.910	.903	.876	.842	.809	.925	.918	.895	.890	.875	.875
.906	.878	.868	.833	.777	.731	.....	.....	.....	.....	.....	.....
.892	.856	.848	.806	.742	.692	.....	.....	.....	.....	.....	.....
.890	.849	.843	.800	.739	.700	.....	.....	.....	.....	.....	.....
.899	.860	.853	.815	.765	.726	.....	.....	.....	.....	.....	.....
.916	.881	.877	.841	.802	.770	.....	.....	.....	.....	.....	.....

TABLE VII

Summary of Comparison Between Calculated and Experimental Compressibility Factors

Gases Investigated	No. of Points of Comparison	Total Percent Error	Average Percent Error	Maximum Percent Error
Eight gases in Phillips Laboratories	68 72	+ 70.50 — 58.70	+1.04 —0.87	+ 3.4 — 2.6
Four gases in Texas A. & M. Laboratories	24 36	+ 26.99 — 85.83	+1.35 —2.38	+ 3.9 — 6.7
Sixteen saturated gases by Standing and Katz (2)	10 6	+ 12.90 — 9.76	+1.29 —1.63	+ 6.7 — 4.6
The Rio Bravo gas by Sage and Reamer (8)	13 2	+ 8.03 — 1.46	+0.62 —0.73	+ 1.6 — 0.9
29 gases total:				
Positive errors	115	+118.4	+1.03	.....
Negative errors	116	—115.8	—1.34	.....
Numerical average	231	274.2	1.19	.....
Algebraic average	231	— 37.4	—0.16	.....

gases range from .591 to 1.074 specific gravity referred to air, and contain up to 7.5 percent nitrogen and up to 1.8 percent carbon dioxide.

The several averages for the errors are listed in Table VII but the two significant numbers are a numerical average error of 1.2 percent and an algebraic average of —0.16 percent for 231 points of comparison. The chart, Figure 1, gives close to true mean values for these 29 natural gases and has an average deviation about in line with the usual accuracy of experimental data and the calculations. The points believed to be in the two-phase region in Table III were not included in the average or maximum. A maximum error as high as 7 percent has been found to occur although a part of this discrepancy may be attributed to errors in experimental results as well as to the compressibility chart.

Density of Natural Gases in the Two-Phase Region

The experimental compressibility factors for the two-phase range in Table III did deviate considerably from the calculated values but gave rather close agreement at higher pressures when in the compressed liquid region. To study the use of the compressibility factor for density calculations in the high-pressure two-phase region, data on a natural gas-natural gasoline mixture were used.[9] The phase diagram for the mixture is given by Figure 4 and includes the regions likely to be encountered in high-pressure gases. The effect of a small amount of liquefaction on the overall density is of special interest in meter calculations.

Table VIII gives the comparison between experimental and calculated densities for the natural gas-natural gasoline mixture. The calculations were made assuming the system density could be computed as an ideal gas corrected by the compressibility factor. The observed volume percentages liquid were taken from the phase diagram, Figure 4. Table VIII demonstrates that the compressibility-factor method can be used to compute the density of a mixture in the single-phase region above the bubble point curve, a short way into the two-phase region below the bubble-point curve, and completely through the two-phase region at high temperatures where a small volume percentage liquid is present. The region in which these calculations may be made is limited to pT_R of 1.05 or higher.

A study of the methane-butane system[10] also indicated that the overall density of a system existing as a small proportion liquid and the remainder gas may be computed at high pressure by assuming the system were a single phase. The explanation of this remarkable behavior lies in the relatively small change in partial molal volumes between the vapor and liquid phases at these conditions. Hence it matters little for the overall density if a portion of the system is in the liquid phase. Caution must be exercised in using this proof as being of general application without regard to position on the phase diagram. However, at pressures above 1000 pounds, at temperatures above the critical temperature of the mixture, and at volume percentages liquid under 10, the presence of the liquid phase is not likely to interfere with the calculation of the average density of the mixture by the compressibility-factor method.

Pseudo Critical Temperatures and Pressures as a Function of Gasoline Content and Gas Gravity

The prediction of the pseudo critical conditions of a gaseous mixture from some easily determined field measurement instead of from the fractional analysis is desirable. The use of gas gravity to characterize the gas has been shown to be of value for gases from one source but to be inadequate for all gases.[1,2] The addition of another characteristic of the gas such as gasoline content should be of value.

Figure 4a was constructed using data on about 40 miscellaneous gases. The 26-70 gasoline content was used as 1.42 times the pentane and heavier content. The relationships between 26-70, test car and charcoal contents are those of a typical Mid-Continent gas but are not necessarily of general application. The curve for effluents for condensate wells permits the prediction of the pseudo critical temperature from the gasoline or liquid content which is the equivalent of gas-oil ratio. Since this curve relates pseudo critical temperature to a single variable, it cannot be expected to be of universal application. This chart was found to be reliable for predicting compressibility factors for gases from sources similar to those used in constructing the chart. Pseudo critical pressures were predicted from the gas gravity alone.

TABLE VIII

Comparison of Calculated and Experimental Densities of Fluid in Single- and Two-Phase Regions

	CALCULATED		EXPERIMENTAL	
Pressure Lb./Sq. In. Abs.	Z	Density gm./cc.	Density gm./cc.	Volume Percent Liquid
			40° F. pT_R=1.13	True T_R=0.91
2890	0.628	0.380	0.376	Single Phase
2524	.569	.367	.366	Single Phase
2452	.556	.364	.361	60.5
2187	.511	.353	.320	43.2
1493	.43	.287	.204	20.7
687	.680	.083	.082	6.6
			87.5° F. pT_R=1.21	True T_R=0.995
2901	.658	.339	.334	Single Phase
2720	.633	.330	.326	Single Phase
2700	.631	.328	.323	46.7
2623	.622	.324	.314	41.7
2524	.609	.319	.300	38.3
2098	.558	.289	.246	28.0
1412	.542	.200	.157	15.2
980	.660	.114	.103	8.9
			160° F. pT_R=1.40	True T_R=1.13
2798	.728	.256	.263	Single Phase
2775	.727	.254	.263	3.9
2612	.718	.242	.246	16.1
2300	.705	.217	.216	16.7
1923	.706	.181	.176	14.1
1482	.738	.13	.132	9.9
962	.815	.079	.082	5.1
			200° F. pT_R=1.49	True T_R=1.20
2955	.788	.235	.243	Single Phase
2628	.774	.213	.221	1.4
2550	.769	.208	.215	4.5
2245	.764	.184	.188	9.4
1937	.769	.158	.159	8.7
1624	.787	.129	.130	7.4
1305	.814	.100	.102	5.9
1070	.842	.079	.082	4.7

High Pressure Gas Measurement

PART II

A Suggested Standard Method for Calculation of High Pressure Gas Measurement

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A STANDARD procedure for converting orifice-meter readings on high-pressure gases into quantities of gas flowing is desirable for the natural-gas and natural-gasoline industries. Such standards have been used for low-pressure gases for many years and cover most of the procedures for high-pressure gases. The chief item upon which complete agreement has not been reached is the correction for deviation of the gas from ideal gas laws. The compressibility factor method is generally accepted and the lack of agreement lies in the method of choosing this compressibility factor for specific cases. The prime purpose of this paper is to suggest standard procedures for selecting meter-correction factors to account for the compressibility of the gas flowing. A brief discussion of measuring the flow of two phases is included.

The Meter Formula

The formula used to compute the flow of natural gas from the meter readings may be written as follows:

$$Q = C\sqrt{\frac{1}{G}}\sqrt{\frac{520}{T_f}}\sqrt{\frac{1}{Z}}\sqrt{P\times h} \qquad (1)$$

in which Q = cu.ft. of gas at 60°F. and base pressure such as 14.65 lbs./sq.in.abs. flowing per unit time

C = orifice coefficient depending on diameter of orifice, diameter of pipe, units of h, standard gravity of gas flowing, etc.

G = gas gravity or molecular weight of gas divided by 29.0, the molecular weight of air

T_f = Absolute flowing temperature of gas, °F.+460

Z = compressibility factor at flowing temperature and pressure $= \frac{PV}{RT}$

P = absolute flowing pressure lbs. per sq.in.

h = differential across orifice, usually in inches of water.

The general procedure is to consider the first three square root terms as correction factors and the equation then becomes:

$$Q = C\times F_G\times F_T\times F_Z\sqrt{P\,h} \qquad (2)$$

in which $F_G = \sqrt{\frac{1}{G}}$ the gas gravity correction factor when C is for a gas gravity of one.

$F_T = \sqrt{\frac{520}{T_f}}$ the gas temperature, correction factor from base temperature of 520°R., 60°F. to flowing temperature.

$F_Z = \sqrt{\frac{1}{Z}}$ the deviation factor or the proper function of the compressibility factor to correct the ideal gas density for deviation from ideal gas laws.

Since the factors can be easily combined, it is suggested that the following nomenclature be considered:

$$F_{TZ} = F_T\times F_Z \text{ and } F_{GTZ} = F_G\times F_T\times F_Z$$

The appearance of the compressibility factor in the final orifice equation as a square root of the reciprocal of the factor is due to its appearance in the original form both to correct the density of the flowing gas and to convert the volume of gas at the flowing pressure to standard volumes.

Several combinations of correction factors may be made for actual meters. For example, the gravity of the gas may remain relatively constant and then the F_G may be combined with the orifice coefficient C. This leaves the temperature and deviation factors to be evaluated and since temperature is a variable in both, the use of a combined temperature-deviation factor. F_{TZ}, is suggested. It will later be demonstrated that all three correction factors are a function of temperature, pressure and gas gravity. Therefore, the combination of all three into a gravity-temperature-deviation factor, F_{GTZ}, should simplify meter calculations without any sacrifice of accuracy.

These suggestions are in line with previous discussions of high pressure metering.[1,12,13,14,15] The orifice coefficient should be in accord with the best practices for heavy walled pipe.[11]

Pseudo Critical Temperatures and Pressures For Gases From the Same Field.

The computation of the meter factors including the deviation from ideal gas laws for cases in which the gas analysis is known is straight forward. However, the problem in the natural-gas and natural-gasoline industry is to find an easily determined characteristic of a gas which will identify its pseudo critical conditions and hence its compressibility factors. The most convenient measurement to consider is the gravity of the gas or molecular weight divided by the molecular weight of air, 29.0.[1,2]

Gases from a given field usually are similar in nature even though of different composition. These gases have been found to give a smooth curve for gas gravity as a function of pseudo critical temperature and pressure. To analyze the behavior of the gases from one field over a period of several years, Oklahoma City (Wilcox) gases were chosen as an example. Figure 7 is a plot of the pseudo criticals calculated from the analyses of a series of gases including high-pressure equilibrium vapors, separator gases, plant intakes and plant residues. Table IX lists the results of calculations on these gases which

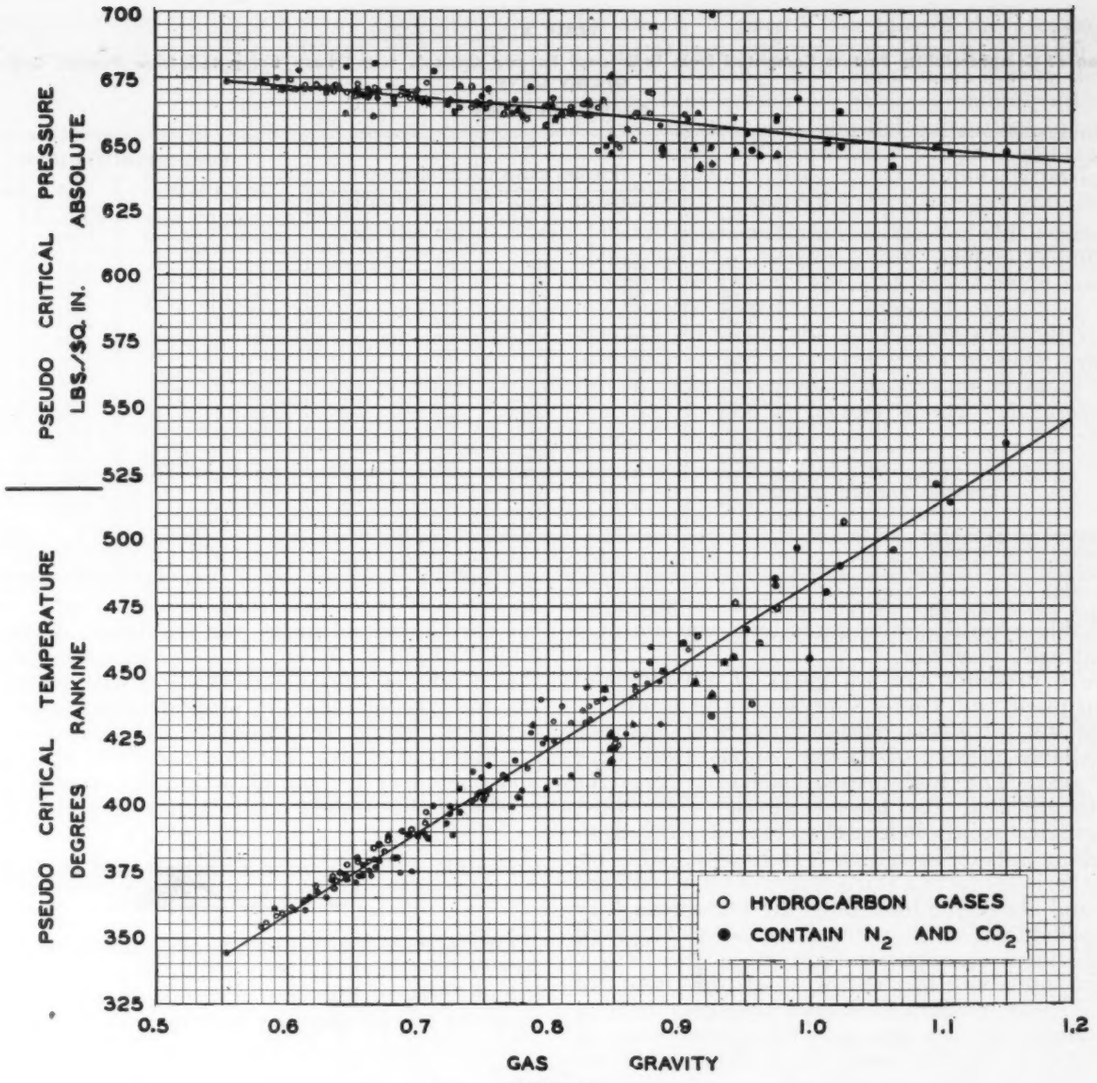

FIGURE 5
Pseudo Critical Properties of 150 Natural Gases

TABLE IX

Comparison of Compressibility Factors Computed from Individual Pseudo Criticals with Those Computed from Pseudo Critical Gas Gravity Curve

OKLAHOMA CITY GASES

Sample No.	Gas Gravity	PSEUDO CRITICAL CONDITIONS				COMPRESSIBILITY FACTORS			
		Calculated from Analyses		Read from Curve Fig. 7		40° F. 1500 Lb.		140° F. 1500 Lb.	
		pT_c	pP_c	pT_c	pP_c	Calculated Pseudo	Fig. 7 Pseudo	Calculated Pseudo	Fig. 7 Pseudo
1	1.108	515	646	524	646	....	....	0.470	0.443
2	0.769	410	663	414	666	0.553	0.537	0.790	0.781
3	0.700	388	666	392	669	0.643	0.630	0.829	0.824
4	1.150	537	646	537	642	....	....	0.400	0.410
5	1.063	495	642	509	650	....	....	0.536	0.500
6	0.611	365	672	363	672	0.723	0.730	0.867	0.867
7	0.990	496	666	485	655	....	....	0.538	0.574
8	1.023	490	649	496	653	....	....	0.564	0.584
9	0.796	423	664	423	670	0.500	0.503	0.757	0.760
10	0.755	406	665	410	666	0.585	0.550	0.776	0.770
11	0.951	466	635	372	657	0.345	0.325	0.636	0.620
12	0.711	399	677	395	669	0.609	0.620	0.814	0.817
13	0.974	485	659	480	656	....	....	0.576	0.593
14	0.803	424	664	425	665	0.495	0.488	0.754	0.750
15	0.635	372	672	370	671	0.700	0.707	0.854	0.858
16	0.906	458	659	458	660	0.367	0.370	0.666	0.666
17	0.678	389	672	384	670	0.645	0.661	0.830	0.834
18	0.787	427	671	420	665	0.485	0.510	0.750	0.768
19	0.885	447	656	452	661	0.499	0.389	0.695	0.683
20	0.876	446	659	448	662	0.412	0.405	0.697	0.695
21	0.775	417	666	416	666	0.525	0.542	0.775	0.777
22	0.907	458	657	458	660	0.373	0.373	0.664	0.663
23	0.975	483	660	481	656	....	....	0.583	0.586
24	0.749	410	667	408	667	0.568	0.563	0.788	0.790
25	0.799	424	663	423	664	0.500	0.470	0.754	0.754
Numerical average deviation	....	....	....	....	....	2.62%		2.38%	
Algebraic average deviation	....	....	....	....	....	—0.83%		+0.90%	

TABLE X

Comparison of Compressibility Factors Computed from Individual Pseudo Criticals with Those Computed from Pseudo Critical Gas Gravity Curve

GRAPELAND GASES

Sample No.	Gas Gravity	PSEUDO CRITICAL CONDITIONS				COMPRESSIBILITY FACTORS			
		Calculated from Analyses		Read from Curve Fig. 6		40° F. 1500 Lb.		140° F. 1500 Lb.	
		pT_c	pP_c	pT_c	pP_c	Calculated Pseudo	Fig. 6 Pseudo	Calculated Pseudo	Fig. 6 Pseudo
1	0.622	369	672	366	670	0.712	0.720	0.857	0.866
2	0.878	454	661	445	658	0.380	0.402	0.675	0.692
3	0.750	402	664	406	665	0.584	0.570	0.806	0.798
4	0.636	372	672	370	670	0.700	0.710	0.854	0.860
5	0.867	443	661	442	659	0.419	0.421	0.708	0.711
6	0.751	404	663	406	665	0.527	0.563	0.802	0.795
7	0.635	373	671	370	670	0.694	0.710	0.852	0.860
8	0.838	439	663	433	661	0.435	0.443	0.718	0.725
9	0.732	397	663	400	666	0.603	0.586	0.813	0.806
10	0.645	377	661	372	669	0.685	0.696	0.845	0.854
11	0.804	431	667	422	662	0.470	0.489	0.738	0.750
12	0.741	401	663	402	665	0.584	0.575	0.803	0.800
13	0.654	380	670	376	668	0.676	0.685	0.845	0.848
14	0.754	415	670	406	665	0.530	0.564	0.778	0.793
15	0.748	404	664	405	665	0.573	0.575	0.802	0.797
16	0.742	412	671	402	665	0.559	0.569	0.787	0.804
17	0.744	402	664	403	665	0.588	0.576	0.804	0.800
Numerical average deviation	....	....	....	....	....	2.11%		1.05%	
Algebraic average deviation	....	....	....	....	....	+1.24%		+0.57%	

are probably typical of the gases over the life of a Mid-Continent reservoir.

Figure 6 presents data on gases of a Grapeland recycling plant and Table X presents the results of computations for these gases. Three gas analyses were available on each of six days spread over more than a year. The high-pressure-absorber residues group together at the lowest gravity. The next higher gravity points below the curve are the computed plant intake including condensate. The reabsorber residues form a third series of points at high gravity and above the line. Both the Oklahoma City and Grapeland gases follow the same curves although they are shown on separate figures.

To evaluate the effect of the small deviations of pseudo critical temperatures and pressures from a smooth curve against gas gravity, comparisons of compressibility factors were determined with the pseudo criticals from the smooth curve and from those given by the gas analyses. Since the greatest errors are likely due to temperature effects, two conditions were selected for these calculations; 40°F. and 1500 pounds and 140°F. and 1500 pounds. The compressibility factors for these two conditions by the two methods are included in Tables IX and X.

The errors are retabulated in Table XI including the average for all gases having gravities under 0.750. The conditions of 40°F. and 1500 pounds is about the worst condition which could be encountered. Although the average error is 2.11 per cent for the Grapeland gases, the maximum deviation in temperatures is 7.0° F. This demonstrates the fact that compressibility factor changes with temperature are more rapid than the proportional absolute temperature change. Inspection of the Grapeland gases on Figure 6 shows that one curve for the residues and one curve for the plant intakes would have reproduced the pseudo criticals almost perfectly.

TABLE XI

Comparison of Compressibility Factors from Individually Computed Pseudo Criticals with Those from Curves vs Gas Gravity

Comparison at 1500 pounds per sq. in.

No. Considered	Gases	Temp. °F.	Percent Algebraic Average Error	Percent Numerical Average Error
18	Oklahoma City	40	— 0.83	2.63
6	Oklahoma City, less than 0.75 gravity	40	+ 0.55	1.51
25	Oklahoma City	140	+ 0.90	2.38
6	Oklahoma City, less than 0.75 gravity	140	+ 0.16	0.36
17	Grapeland	40	+ 1.24	2.11
11	Grapeland, less than 0.75 gravity	40	+ 0.58	1.92
17	Grapeland	140	+ 0.57	1.05
11	Grapeland, less than 0.75 gravity	140	+ 0.27	0.88
139	Miscellaneous gases	40	— 0.66	3.94
150	Miscellaneous gases	140	— 0.12	1.82
77	Miscellaneous gases, less than 0.75 gr.	40	+ 0.02	1.62
77	Miscellaneous gases, less than 0.75 gr.	140	— 0.10	0.62

Pseudo Criticals as a Function of Gas Gravity For 150 Natural Gases

One hundred and fifty gas analyses were collected from miscellaneous sources including the above. The pseudo critical temperatures and pressures and gas gravities were computed with data similar to Tables

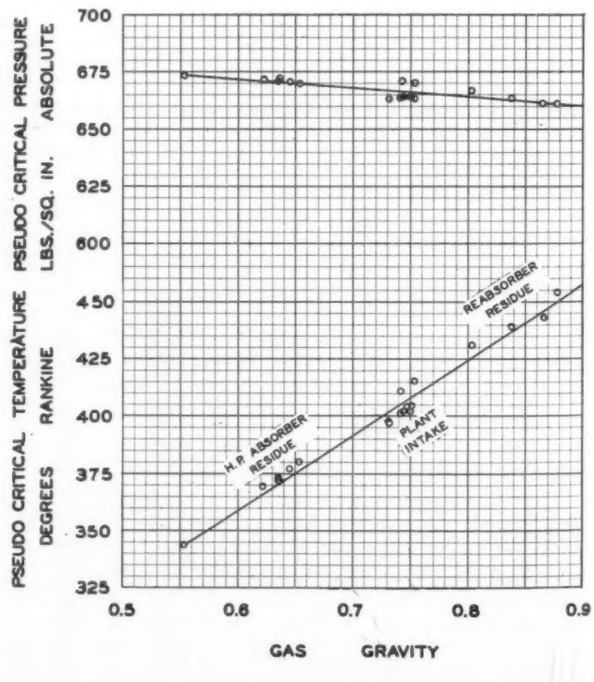

FIGURE 6

Pseudo Critical Properties of Grapeland Gases

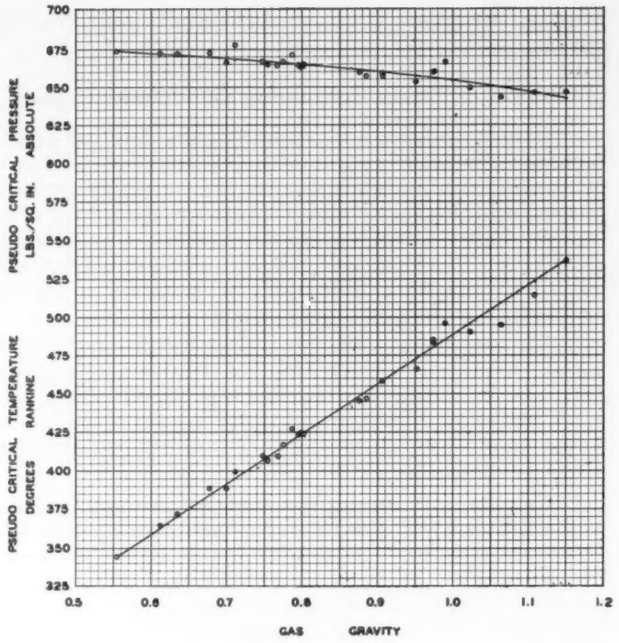

FIGURE 7

Pseudo Critical Properties of Oklahoma City Gases

TABLE XII

Typical Calculation of Meter Factors—Grapeland and Oklahoma City Gases

Gas gravity = 0.600. $pT_c = 359$. $pP_c = 672$.

Temp. °F.	Pressure, Lb./Sq. In. Abs.	pT_R	pP_r	Z	$\frac{1}{Z}$	$\sqrt{\frac{1}{Z}}$	$\sqrt{\frac{520}{TZ}}$	$\sqrt{\frac{520}{GTZ}}$
40	500	1.392	0.744	0.902	1.109	1.052	1.072	1.388
	1000		1.488	0.812	1.231	1.110	1.132	1.463
	1500		2.232	0.738	1.356	1.163	1.188	1.531
	2000		2.976	0.700	1.430	1.196	1.220	1.572
	2500		3.720	0.703	1.422	1.192	1.215	1.570
	3000		4.464	0.729	1.371	1.170	1.192	1.540
60	500	1.450	0.744	0.916	1.091	1.044	1.044	1.350
	1000		1.488	0.840	1.190	1.090	1.090	1.409
	1500		2.232	0.781	1.280	1.131	1.131	1.401
	2000		2.976	0.744	1.345	1.160	1.160	1.499
	2500		3.720	0.740	1.352	1.162	1.162	1.500
	3000		4.464	0.761	1.312	1.145	1.145	1.480
80	500	1.504	0.744	0.925	1.081	1.040	1.021	1.318
	1000		1.488	0.861	1.160	1.078	1.059	1.365
	1500		2.232	0.811	1.232	1.110	1.091	1.406
	2000		2.976	0.779	1.284	1.132	1.112	1.433
	2500		3.720	0.774	1.292	1.137	1.115	1.440
	3000		4.464	0.790	1.268	1.128	1.108	1.430
100	500	1.560	0.744	0.936	1.069	1.034	0.995	1.280
	1000		1.488	0.880	1.136	1.066	1.027	1.318
	1500		2.232	0.835	1.199	1.095	1.056	1.355
	2000		2.976	0.808	1.238	1.112	1.072	1.375
	2500		3.720	0.797	1.254	1.120	1.080	1.393
	3000		4.464	0.813	1.230	1.110	1.070	1.380
120	500	1.618	0.744	0.946	1.058	1.029	0.974	1.255
	1000		1.488	0.895	1.119	1.058	1.001	1.290
	1500		2.232	0.857	1.168	1.051	1.023	1.324
	2000		2.976	0.834	1.200	1.095	1.036	1.338
	2500		3.720	0.822	1.218	1.104	1.045	1.352
	3000		4.464	0.835	1.198	1.094	1.036	1.337
140	500	1.671	0.744	0.951	1.051	1.024	0.954	1.231
	1000		1.488	0.909	1.100	1.049	0.975	1.260
	1500		2.232	0.872	1.146	1.072	0.998	1.29
	2000		2.976	0.853	1.171	1.081	1.007	1.300
	2500		3.720	0.842	1.188	1.090	1.014	1.305
	3000		4.464	0.855	1.170	1.081	1.007	1.300
160	500	1.727	0.744	0.959	1.042	1.020	0.934	1.208
	1000		1.488	0.921	1.075	1.038	0.950	1.228
	1500		2.232	0.892	1.120	1.059	0.969	1.251
	2000		2.976	0.871	1.149	1.072	0.980	1.270
	2500		3.720	0.865	1.156	1.075	0.984	1.271
	3000		4.464	0.875	1.142	1.069	0.976	1.263

IX and X. Figure 5 is a plot of the pseudo critical temperatures and pressures as a function of gas gravity. The only distinction made among the points is the identification of gases containing nitrogen or carbon dioxide in reported quantities since these gases would not necessarily follow a general curve for hydrocarbon gases. Considerable scattering of the points occurs especially at higher gas gravities.

In order to evaluate the effect of this scattering of points on the compressibility factors, comparisons similar to those of Tables IX and X were made with the results shown in Table XI. The 3.94 percent average error for the 40°F. compressibility factors probably includes several gases of high gravity in the two-phase region. The average error of 1.8 percent for the 140°F. factors is relatively low for this general relationship.

Meter Factor Charts

Meter factors which correct gas volumes for deviation of gases from ideal may be computed as a function of temperature, pressure and gas gravity provided the pseudo critical temperature and pressure are a function of gas gravity. The deviation factor alone is the square root of the reciprocal of

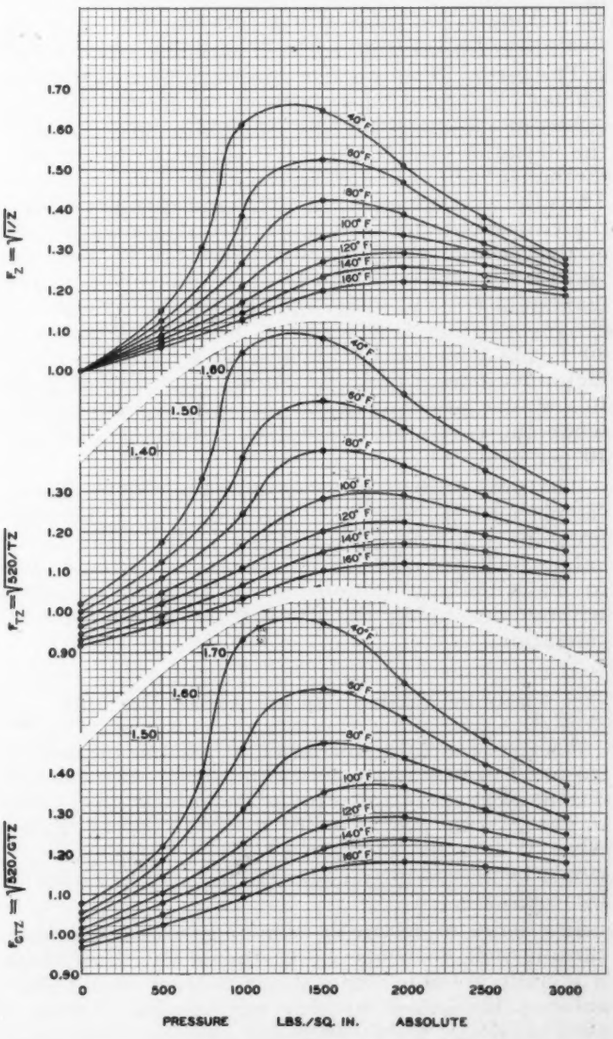

FIGURE 8

Meter Factors for Grapeland and Oklahoma City Gases

the compressibility factor and may be computed as shown in Table XII. The deviation factor may be combined with the temperature and gravity factor as previously described.

Figure 8 is a plot of the deviation-temperature factor, F_{TZ}, for Oklahoma City and Grapeland gases since they have the same function of pseudo critical conditions with gas gravity. It is necessary to make individual charts for each gas gravity and interpolate between these charts for intermediate gravities. Tables could be set up to give the usual correction factors for any series of gases.

Since the gas gravity must be known to find the meter factor, it is just as convenient to include the gravity factor with the temperature and deviation. Figure 9 gives the three types of meter factors for the Oklahoma City and Grapeland gases. There seems to be little advantage of one over the other from the type of curves involved. Also, it may be shown that ease of interpolation between gas gravities shifts from one type of chart to another depending upon the specific conditions.

Figure 10 is a plot of the F_{GTZ} factors corresponding to the gas gravity-pseudo critical property curves of Figure 5 for miscellaneous gases. The sensitivity of the meter factor at low temperatures at pressures from 1000 to 2000 pounds is observed again. Also some of the gases of high gravity may be in the two-phase region over part of the range represented.

The errors given for the compressibility factors by Tables IX, X and XI should not be construed as the errors in the meter factors. Since the square root of the deviation enters the meter formula, the error in the meter factors are about one-half of those shown. Thus the average errors at 40°F. and 1500 pounds for the Grapeland and Oklahoma City gases due to use of the pseudo critical-gravity curve are 1.1 per cent and 1.3 per cent respectively of the meter factor. The maximum error in meter factor for any of these two groups of gases is 3 per cent. For the 139 gases at 40°F. and 1500 pounds, the average error in the meter factor becomes 2 per cent due to assuming all gases follow the pseudo critical-gas gravity relationship while the maximum error may become as large as 10 per cent.

The total error in gas measurement due to density calculations includes the uncertainties in the compressibility factor plot and may increase the above values by 1 per cent on the average. It is impossible to make definite statements on probable accuracy without describing the T_R and P_R etc. under consideration.

Gasoline Content as an Added Variable

As stated earlier, the gasoline content would be expected to help characterize the pseudo critical conditions of gases but was found to be little added help to gas gravity when applied to miscellaneous gases. Also, if it were to be used for specific gases, it would be necessary to make a meter correction factor for each gas.

If a series of relatively similar gases such as condensate-well effluents were studied by themselves, it is quite possible that a liquid content would characterize the gases so that any deviation from a pseudo critical temperature-gas gravity curve could be measured by this variable. In that case, the gasoline content would not be used for individual gases but to establish the pseudo critical-gas gravity curves.

Metering of Gases Containing Condensed Liquids

Orifice meters are not generally considered as satisfactory for measuring a mixture of two phases. However, condensate well effluents are normally in two phases and most rich high-pressure gases form a liquid phase during pressure decreases occurring with flow. The previous discussion of metering assumed single-phase flow but the need for a meter to handle two phases is increasing.

Many operators separate the liquid from the gas phase just prior to metering to eliminate the difficulty of handling gas containing liquid. In some cases the liquid is dumped back into the gas line below the meter, thus avoiding liquid accumulation at the orifice plate.

Until recently the prospect of metering mixtures of liquids and gases did not appear to be very great. However, two facts are now available which increase the possibility of two-phase metering. First, it is possible to make the stream homogeneous to the extent that it can be properly sampled.[16,17] Second, the density of the flowing stream can be computed re-

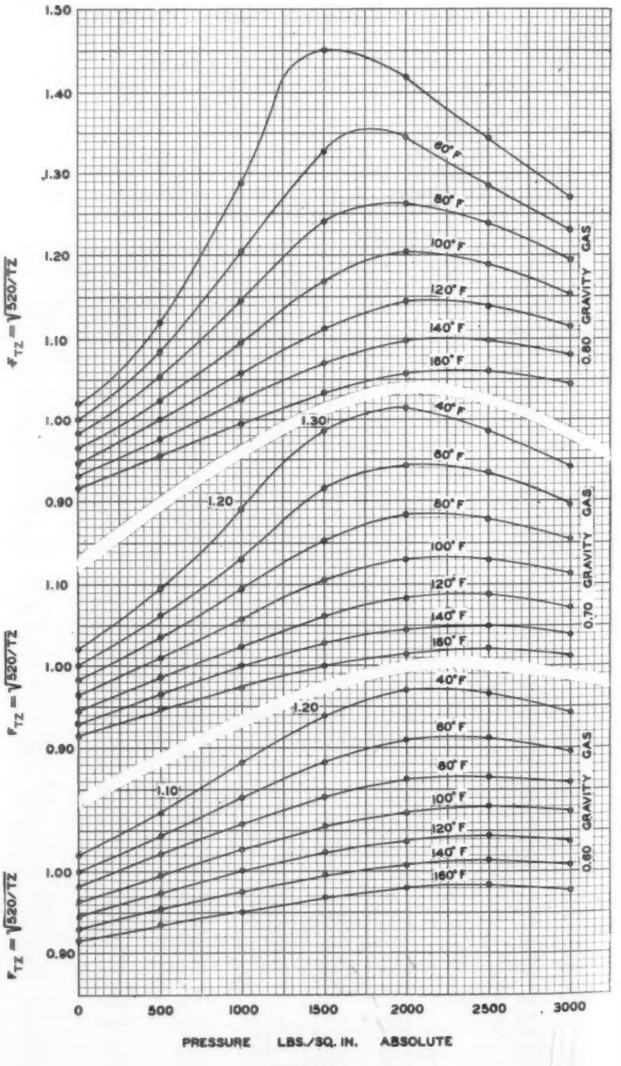

FIGURE 9
Three Types of Meter Factors for 0.9 Gases

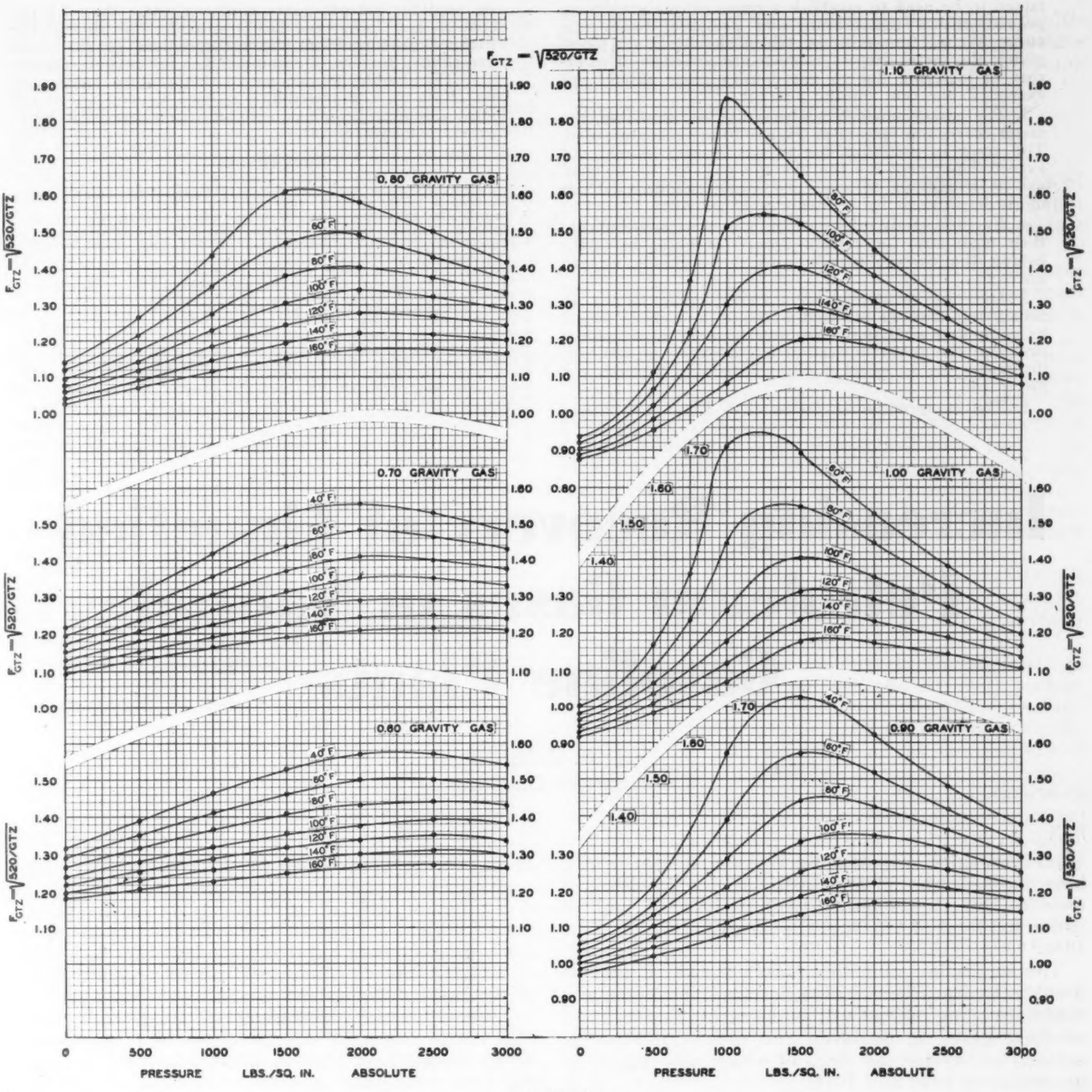

FIGURE 10
Gravity-Temperature-Deviation Meter Factors for Average Natural Gases

gardless of whether a single phase exists or whether a small quantity of liquid is present.

Operators report satisfactory mechanical operation of meters if the velocities are high enough to give adequate dispersion of the liquid to simulate an homogeneous fluid. The recent tests of sampling two-phase flow should increase the knowledge of the homogeneity of the two-phase streams. If the mechanical devices can be assured to give the correct differential across the orifice, small amounts of liquid at high pressure are not likely to invalidate the usual density calculations.

When metering high-pressure gases containing a liquid phase, special precautions must be observed when obtaining the gas gravity. Satisfactory sampling of the flowing stream followed by separation of the liquid and gas at a lower pressure, below 500 pounds, should provide data for computing the flow-stream molecular weight. A gravity-balance test could be devised to operate on the atmospheric-pressure gas with corrections for liquid recovered in a specially designed receiver.

Recommended Procedure for Establishing Meter Factors

The following procedures for establishing standard meter factors including the deviation from ideal gases are as follows, depending upon the accuracy desired:

1. For the highest degree of accuracy, a gas analysis should be obtained to eliminate any doubt as to pseudo criticals. The errors in metering due to gas density alone should not exceed 1 per cent on the average.

2. For average metering of high-pressure gases of varying gravity, representative analyses should be ob-

tained to be used to establish a curve of gas gravity vs pseudo critical temperature and pressure. From this curve a chart or series of tables should be prepared giving the meter factors at even gas gravities. The errors in metering due to gas density alone should not exceed 2 per cent on the average.

3. For cases in which analyses are not available, the meter-correction factors of Figure 10 are recommended. The error in metering due to gas density should not exceed 3 per cent for the average gas, but an unusual gas at conditions to give low compressibility factors might be in error by as much as 10 per cent.

4. Further study of gasoline contents may indicate their usefulness for certain groups of gases in establishing the correct pseudo critical conditions vs gas gravity.

5. Metering of gases above 1000 pounds known to contain less than 10 per cent of liquid by volume should be computed as if the entire stream were a gas phase, provided the meter operation is indicative of uniform dispersion of the liquid in the gas passing through the meter run.

6. The compressibility factor plot, Figure 1, should be used for natural gases containing less than 7.5 per cent N_2 and 2 per cent carbon dioxide. For appreciably higher concentrations, the measurement of the compressibility factors is recommended for reliable results.

7. The double importance of temperature because of its effect on compressibility factors as well as on the ideal volumetric expansion should be recognized in high-pressure measurement.

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Increasing Recovery of Liquefied Petroleum Gases in Natural Gasoline Plants*

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TOTAL sales of liquefied petroleum gases as such, have increased on an annual basis from 221,641 gallons in 1922 to 313,456,000 gallons in 1940, and an estimated total of 445,000,000 gallons during the year 1941.[1]

The increasing number of uses to which the individual hydrocarbons in the liquefied petroleum gas range are being put, as well as the favorable reception of these gases as domestic and industrial fuels, is causing an accelerated demand which was especially noticeable in 1940 and 1941.

Since December 7, 1941, liquefied petroleum gases, particularly the butanes, have assumed a new and greater importance. Prior to the inception of the war program, only a small part of the natural gasoline industry's products had been used in the manufacture of 100-octane aviation gasoline, and even less in the manufacture of synthetic rubber.[2]

The present program has been variously estimated at 200,000[3] barrels or more per day of 100-octane aviation gasoline. In order to present some idea of the enormous volumes of liquefied petroleum gases which will be required to produce this volume of aviation gasoline, the following figures based on the alkylation process are illustrative:

It has been reported that the alkylate required in the blend may vary from 15 percent to 60 percent of the total, depending upon the characteristics of the other blending materials used. Assuming 45 percent as an average figure, then for 200,000 barrels of 100-octane gasoline approximately 90,000[4] barrels of aviation alkylate will be required. It is reasonable to expect a yield of approximately 80 percent based on a charging stock of butylene and isobutane in a ratio of 1:1.2. On these assumptions it would require about 52,000 barrels of butylene and about 62,000 barrels of isobutane to make 90,000 barrels of aviation alkylate.[4] Part of the isobutane will be recovered from refinery tanks vapors, part from stabilization of the primary cut from crude oil, part from the natural gasoline industry, and the remainder from isomerization of normal butane. Furthermore, in order to obtain sufficient butylene, it will be necessary to convert some portion of normal butane by means of the catalytic and thermal processes.[5]

From published reports during the week of April 9, 1942,[6] it was noted that 14 oil refining companies, representing 53.81 percent of the nation's total crude-oil refining capacity, seven chemical concerns, and four rubber manufacturers have accepted contracts with the federal government to build and operate facilities for production of 700,000 tons of synthetic rubber annually.

For the manufacture of 700,000 tons of synthetic rubber per year, enormous quantities of butane will undoubtedly be required. In the case of Buna-S rubber, if we assume a 45 percent by weight conversion of butane to rubber, then it would probably be necessary to produce as much as 700,000,000 gallons of butane per year for this purpose alone.[7, 8] Of this

*Before the annual meeting of the Natural Gasoline Association of America, Tulsa, May 15, 1942.

total, approximately one half, under some estimates, will be obtained from refinery gases, and the balance from natural gasoline, recycling and repressuring plants.

In order to secure adequate supplies of the liquefied petroleum gases for the many purposes to which these gases are put, but particularly for the manufacture of aviation gasoline, Recommendation No. 25, Part No. 1512 was issued to the natural-gas and natural-gasoline industries by the Office of the Petroleum Coordinator for National Defense under date of January 26, 1942. Paragraph 1512.3 of Recommendation No. 25 is quoted to-wit:[9]

"Extraction and Production of Existing Plants to Be Increased.

"All persons, natural or artificial, presently owning or operating any natural-gasoline-extraction plant, recycling plant, pressure-maintenance plant, or repressuring plant shall increase the percentage of butane and isobutane extracted from the gas processed at such plant, or plants, to the maximum quantity economically possible, and shall increase the production of butane and isobutane in liquid form at such plant, or plants, to the maximum quantity economically possible."

Since January 26, 1942, the synthetic rubber program has reached a stage of equal or greater importance than the 100-octane aviation gasoline program, and more recently, indications are that the rubber program may be extended to 1,000,000 tons annually and possibly more. Therefore, it is impossible to stress too strongly the magnitude of the problem facing the natural gasoline industry in preparing itself for maximum participation in the war effort. This paper will be limited to suggestions of ways and means of increasing the extraction of liquefied petroleum gases with existing equipment only. No attempt will be made to present any fundamentally new ideas. Instead, certain practical methods, previously presented, or in use, by others will be reviewed briefly, and references given for further reading by those who care to do so.

Fundamental Analyses and Plant Balance

Unless sufficient recent data are on hand to accurately determine the present extraction efficiency of the plant, it is recommended that sufficient fundamental, or low-temperature distillation, analyses be made to obtain a plant balance. In any event, such analyses should be made on the inlet and outlet gases, and on any vapors being lost from the plant. Samples should be as nearly representative as possible of average normal operating conditions. If the composition of the input gas is continuously changing due to well operations or other causes, it would be advisable to obtain composite samples over a period of several hours, or even over a full 24-hour period.

From the analyses of the inlet and outlet gases, the absorber efficiency for such components under existing conditions can be calculated,[10] and a decision made as to what changes or additions are necessary or justified to increase the extraction of the low-boiling components; viz., butane and isobutane.

Theoretical Considerations

Cox and Arnold,[10] in a paper read before the California Natural Gasoline Association in July, 1929, presented the following formula for the oil and gas ratio required to absorb all of the normal butane that any particular type of absorber is capable of recovering under average conditions.

Oil ratio = vapor pressure of normal butane at the temperature of the oil leaving the absorber multiplied by 75, and this result divided by the absolute working pressure of the absorber, using the same units of pressure.

Stated numerically this formula is:

$$R_o = \frac{75 \times nP_t}{P}$$

This formula illustrates the fact that with increased pressure, less oil is required. It also illustrates that with reduction in absorber bottom temperature, less oil is required.

On the other hand, it is obvious that if oil rates are held constant, then with increased absorber pressure, and/or reduced absorber bottom temperature, extraction efficiencies will be increased.

In May, 1930, Alois Kremser presented his "Theoretical Analysis of the Absorption Process" before the Natural Gasoline Association of America.[11] In this analysis, Kremser derived certain absorption factors which are of great practical value in the design and operation of absorption equipment. Certain definite conclusions may be drawn from this work:

1. For economical operation, and maximum extraction efficiencies, an absorber should have a minimum of 12 theoretical plates.

2. A 16-plate absorber of moderate plate efficiency will in general give better performance than an absorber of more elaborate design; but having a lesser number of plates.

3. Absorption factor is directly proportional to absorber pressure and oil rate, and inversely proportional to the molecular weight of the absorption oil, and to the vapor pressure of the individual component to be extracted taken at the temperature of the oil leaving the absorber.

4. For 99 percent extraction of normal butane with an absorber having 12 theoretical plates, a normal butane absorption factor of about 1.3 will be required. The isobutane absorption factor in that case would be about 0.85, which means that only about 85 percent of the available isobutane would be absorbed from the gas. For complete extraction of isobutane, the normal butane absorption factor will have to be increased to slightly less than 2.0.

If the number of theoretical plates were increased to 16, the absorption factor required for any single component would be reduced to 1.2, and for an infinite number of plates, this factor would be about 0.99. Since it is doubtful if any absorber now in operation has a plate efficiency of 100 percent, it will probably be more economical for maximum extraction of the liquefied petroleum gases to use more than 16 actual plates, in order to keep oil rate requirements as low as possible. Unless plate efficiencies are unusually low, 24 actual plates should give excellent results.

5. From statement (3) above, it is obviously an advantage to use a high-gravity, low-molecular-weight absorption oil where possible. Kremser found that the absorption efficiency of the oils investigated increased approximately 2 percent for every degree increase in gravity between 32 degrees and 40 degrees API.

Since stripping of the fat oil is the opposite of absorption, the lighter oil is more difficult to strip. Only plants equipped with modern stripping equipment should attempt to use the very low-molecular-weight oils, for the reason that while increased oil circulation will compensate for the lower absorption efficiency of heavier oil, there is no complete remedy

against inefficient stripping. The only partial compensating factors being high-pressure absorption, and adequate cooling of the lean oil.

6. The absorption factor as stated in (3) above is an inverse function of the vapor pressure of the individual component to be extracted. Because of the fact that the absorption factor is dependent on oil temperatures, perhaps in the minds of some there may be a question as to which of the temperatures, inlet or outlet, is the more significant. Obviously it is very important that the correct temperature should be used. According to Kremser, where the absorption factor is below unity, the equilibrium at the bottom of the absorber will control. With large absorption factors, the top temperature will be more indicative of the degree of extraction. However, conservative practice recommends that the outlet oil temperature be used, in which case operating conditions will actually be somewhat more efficient than indicated by the computations.

7. The absorption factor is directly proportional to both the absolute absorber pressure and the oil ratio. This does not hold exactly true under certain conditions. For instance, if the pressure is doubled, the increased saturation of the rich oil would cause a corresponding increase in absorber bottom temperature, which in turn would prevent the absorption factor from increasing in direct proportion to the increased pressure. Conversely, if the oil ratio is doubled at constant pressure, i. e., with no change in pressure, then the absorber bottom temperature will be lowered, and a somewhat higher absorption factor will be obtained than that computed by direct proportion.

Therefore, proper allowance should be made for the effect of absorber bottom temperature on absorption factor, particular at high-pressure plants.

Practical Considerations

A general survey should be made of plant equipment now in use.

1. Number of trays in absorbers.
2. Present operating pressures, and the possibility of raising absorber pressure.
3. Oil-circulation equipment, and the possibility of increasing oil rates, either at present absorber pressures or at higher pressures.
4. Lean-oil temperature at inlet to absorbers. Possibilities of providing more adequate cooling with existing equipment by means of cleanout work, alterations in cooling tower, water distribution, or other means which may be suggested by the inspection.
5. Lean-oil saturation. All of Kremser's theory of absorption assumed a negligible saturation of the lean oil. Adequate means for thorough stripping of the oil should be provided, including measurement of the stripping steam and efficient laboratory control.
6. Possibilities of providing additional compressor capacity for refrigeration work by transfer of load to underloaded compressors.

A general survey should be made of such idle equipment as may be located at non-operating plants, warehouses and surplus material yards. This survey should include absorbers, exchangers, cooling towers, cooling sections, gas-engine compressors, pumps, and the necessary fittings and other materials which might be required for installations at new locations.

One practical method of increasing the number of effective absorber plates is to place two absorbers in series. If each absorber alone has 12 actual plates, then in series the effect will be similar to that of one absorber having a total of 24 actual plates. In this arrangement the gas should enter No. 1 absorber at the bottom, pass out at the top, and enter No. 2 absorber at the bottom. The lean oil should enter the top of No. 2 absorber, counter-current to the gas flow, and be trapped out at the bottom into a suitable surge tank. A pump should then be provided to transfer the partially enriched oil from the surge tank through an oil cooler to the top of No. 1 absorber. This arrangement provides inter-cooling, which will tend to remove the heat of absorption acquired in No. 2 absorber. The compensating advantages should more than offset the disadvantage of using an additional pump, which in most cases will be on comparatively light load, due to a low differential in oil circuit pressures between intake and discharge of pump.

Desirable Properties in an Absorption Oil

Due[12] to the complexity and variety of crude oils, it is almost impossible to obtain from any one of them an absorption oil which has every desirable feature. Therefore, the following desirable properties of an absorption oil are listed according to their relative importance:

1. The molecular weight should be low, as absorption efficiencies increase with decrease in molecular weight of the absorption oil.
2. The oil should have a low average boiling point.
3. The boiling range should be short, i.e., around 100° F.
4. The initial-boiling point should be as low as practicable with the type of distillation equipment employed, but probably should not be below 400° F. in most cases.
5. The gravity should be between 38 degrees and 40 degrees API (See [5] under Section 2).
6. The oil should contain a low percentage of unsaturated hydrocarbons, due to their poor stability to heat and air. On the other hand, a high percentage of napthene and paraffin hydrocarbons are desirable as they are the best absorbents, and resist oxidation, or deterioration from heat.
7. The oil should be free from organic acids and refining agents.
8. The oil should have low pour and cloud tests. The pour point should be considerably below the lowest operating temperature.
9. The oil should be sulphur free.
10. The color should be 16 to 21 Saybolt as an indication of refinement.

Oil Reconditioning Stills

Regardless of how efficient a virgin absorption oil may be, it cannot maintain its original efficiency indefinitely when in use. On the other hand, by use of continuous rerun stills, the oil can be kept at a high percentage of its original efficiency.

Contamination of absorption oil is caused by foreign elements entering the oil circulation system. These include rust and dust from pipe lines, lubricating oil from compressors, and in some cases crude oil, due to oil separators overflowing and filling gathering lines with crude. The rate of contamination depends upon local conditions, and the efficiency of plant-intake scrubbers.

Deterioration of absorption oil in actual use, according to I. N. Beall,[13] is chiefly due to oxidation and pyrogenesis. These two phenomena work together to produce sludge and gum, causing a lengthening of the distillation range, a decrease in effective oil ratio, and an increase in power consumption.

Several types of oil-reconditioning stills have been

used. These include such early types as a small steel tank mounted in a brick furnace, or an oil-field-type boiler, insulated and equipped to distill oil. Some plants have installed rather elaborate units, including fractionating columns and automatic controls. Others utilize a type that is similar in some respects to a Scotch marine boiler, except that no return tubes are used; the hot gases passing through the firing tube only. In some instances the firing tube, or tubes, which may be one tube or more, is installed in the shell horizontally, and with modified Dresser connections for quick removal for cleaning. Others favor scrapers for cleaning the tube, or tubes. The scrapers fit around the tubes inside the shell and are moved back and forth by means of rods extending through stuffing boxes on the front head of the still.

At least two or more licensed types of[14] absorption oil reconditioning system designs are available.

It is recommended that where the absorption oil is in very poor condition, and where heat-exchange efficiencies are low, due to deposits on tubes in the oil circulation system, that the entire system oil be dumped, and the system cleaned by means of circulating some suitable cleaning compound. In severe cases, it may also be necessary to remove the heads from exchangers and tube bundles for manual cleaning with augers and brushes. The system should then be filled with fresh virgin oil and operations resumed.

The oil rerun still should be started soon after resuming operations, in order to maintain the efficiency of the new oil as long as possible.

Absorber Pressures

While absorption factor is directly proportional to both the oil ratio and the absolute absorber pressure, it is usually more economical to obtain an increased absorption factor by means of elevating pressures than by increasing oil rates. This is particularly true where a shortage of residue gas for fuel exists, or where the residue gas has a sales value.

In most plants now operating at absorber pressures of less than 50 pounds, gauge, it will be found that these pressures can be safely raised to 60 or even 75 pounds, gauge. However, before doing so, it would be well to check the safe working pressures of the equipment involved with the manufacturer, and in cases where corrosion is suspected, it would be advisable to make an internal examination of this equipment before raising pressures much above present levels.

In some instances it may be found desirable to install high-pressure absorption equipment if such is available, particularly at points where residue gas is now being boosted into high-pressure lines. It was our privilege recently to examine operating data from a plant[15] operating at 300 pounds gauge absorber pressure, and with oil rates sufficient to maintain outlet oil temperature at approximately 100° F. Low temperature analyses of the inlet and outlet gases were as follows:

	Inlet Gas Mol. Percent		Outlet Gas Mol. Percent
C_1	74.24	C_1	88.17
C_2	9.24	C_2	9.09
C_3	7.51	C_3	2.74
i-C_4	1.30	i-C_{4+}	0
C_4	3.03		
C_{5+}	4.68		
	100.00		100.00

Oil ratio in the above instance amounted to 30.8 gallons per M cubic feet, and actual extraction checks reasonably close to a normal butane factor[11] of 2.71 for 100 percent extraction of isobutane, and approximately 59 percent extraction of propane. Actual extraction of propane was 63.52 percent. This higher actual extraction bears out the earlier statement that where bottom temperatures are used in computing the absorption factor, the computations are conservative.

Refrigeration

In recent years, many operators have resorted to refrigeration as a means of chilling the lean oil, and in a number of instances refrigeration is being used to remove the heat of absorption from the oil, part way down the absorber, as well as chilling the lean oil entering the top of the absorber. Either is an effective and comparatively simple and inexpensive method of increasing extraction efficiencies at the average gasoline plant. This is particularly true where idle or under-loaded compressor capacity exists. One of the liquefied petroleum gases is usually employed as the refrigerant. If possible, a reasonably pure hydrocarbon, either butane or propane should be used, since the mixed hydrocarbon presents the bad feature of high condensation pressure as related to vaporization temperature pressure. This, of course, increases the ratio of compression and the horsepower required for any given Btu extracted per hour.

As an example: A liquefied petroleum gas mixture, having a mol percent as follows C_3 — 20 percent, i-C_4 — 30 percent and C_4 — 50 percent, would have a vapor pressure of 85.6 at 100° F. Pure normal butane, of course, would have only 52 pounds absolute at

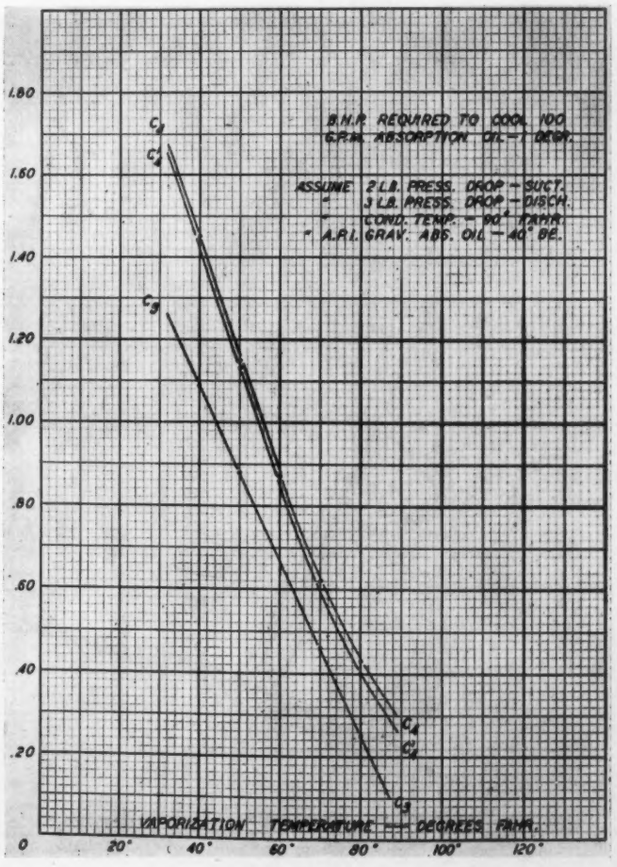

FIGURE 1

100° F. If we vaporize these refrigerants at 60° F. the pressure on the vaporizer, i. e., compressor suction, will be approximately the same in both cases, or 26.3 pounds absolute, because it is necessary to lower the pressure to a point where the heaviest component in the mixture will vaporize at the vaporization temperature. However, the pressure required to condense the liquefied petroleum gas mixture will be 85.6 pounds, or 33.6 pounds higher than for pure butane. The compression ratio for the mixture would be 3.25 while that for pure butane would be 1.98. The difference in horsepower required, per million cubic feet, would be approximately 28 horsepower greater for the mixture than for the pure butane.

In many cases, great improvement in extraction efficiency can be obtained with refrigeration equipment salvable around most plants. The same conditions prevail in cooling absorption oil by refrigeration as apply to any other efficient heat transfer. It is desirable to pass the oil through the tubes of the cooler in order to obtain turbulent flow. The ebullition of the refrigerant helps to maintain turbulence in the shell of the cooler and obviates one of the problems of heat transfer.

It might be mentioned here that any cooling done by refrigeration must be offset by additional cooling load on condensing equipment equal to the Btu per hour handled by coolers, plus the heat of compression; otherwise, the addition of refrigeration equipment adds to the total Btu per hour load on the cooling tower.

Self-explanatory charts[16] furnished will show graphically the horsepower required per million cubic feet per day, Figure 1; the horsepower required to cool 100 gallons per minute one degree, Figure 2; and the increase in extraction resulting from lowering the absorption oil temperature, Figure 3.

Removal of Light Gases from Fat Oil

So far this discussion has been principally concerned with the actual extraction of the liquefied petroleum gases from the gas processed in the absorber. It should be remembered that with the increased absorption factor required for maximum extraction of butane, the absorption of propane, ethane and methane also will increase. The presence of larger quantities of these high-vapor-pressure components in the fat oil amplifies the problem of maximum recovery of the butanes from the oil.

Some methods for reducing the C_4 losses on the condensing and fractionating and of manufacture include:

1. De-ethanizing the fat oil by means of an oil fractionator.
2. A series of pressure step-down vent tanks installed so as to vent, as closely as possible, the methane and ethane from the first tank. The retained methane and ethane, a large portion of the propane, and some amount of the heavier fractions might then be vented from the second and lower pressure tank to a reabsorber. Vapors from the third or low-pressure tank might enter a recompressor, or possibly the vapor condenser on the distillation unit.

Follow-Up on Operations

For best results in operation, it is essential that proper follow-up be made of all pertinent operating data, daily. This should be the duty of a competent and experienced engineer, familiar with the design

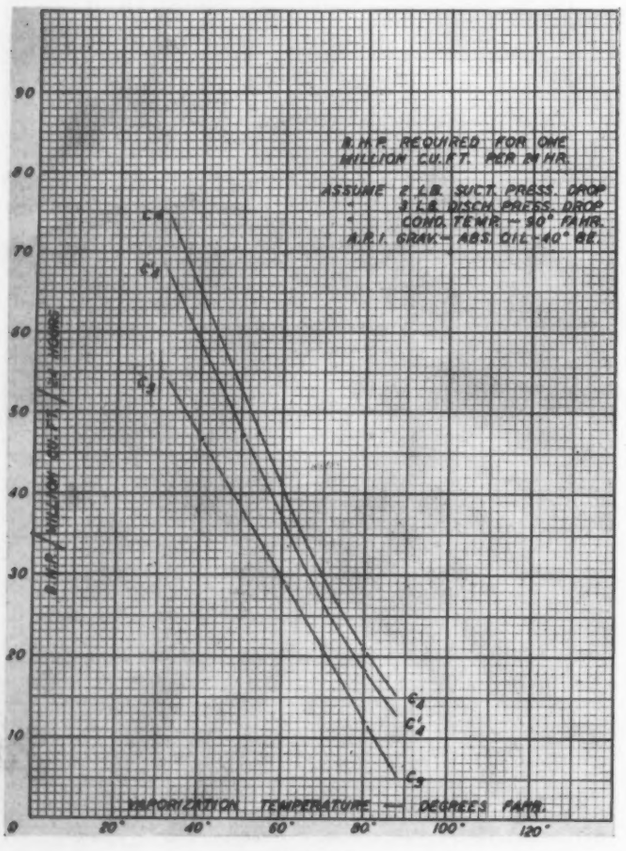
B.H.P. REQUIRED FOR ONE MILLION CU. FT. PER 24 HR.
ASSUME 2 LB. SUCT. PRESS. DROP
3 LB. DISCH. PRESS. DROP
COND. TEMP. — 90° FAHR.
A.P.I. GRAV. — ABS. OIL — 40° BE.
B.H.P. / MILLION CU. FT.
VAPORIZATION TEMPERATURE — DEGREES FAHR.

FIGURE 2

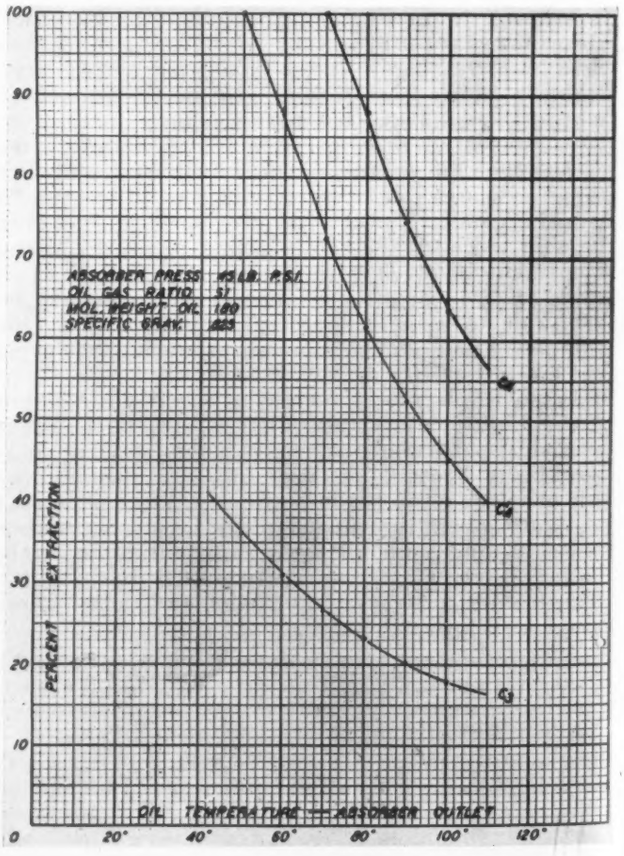

FIGURE 3

and operating conditions of the plant, or plants, under his observation.

It has been suggested that the Technical Committee of the Natural Gasoline Association of America be assigned the problem of determining the most essential data for intelligent analysis of plant operations for use by the industry. This would also facilitate the interchange of ideas within the industry, in our all-out effort to supply sufficient liquefied petroleum gases for the war program.

Economics

The question naturally arises: How far can the natural-gasoline operator go in adding investments, increasing his operating costs, possibly rerouting his processing steps, all to squeeze the last gallon of the butanes from his gas? The economic limits will vary with the individual plant, and there is considerable difference in opinion as to just what these limits are. Unless the operator has some definite idea of prices in advance, he cannot make a reliable estimate of the expenditures he can justify. As a liquefied petroleum gas fuel, butane has not been too attractive to some operators, due to various reasons, including the difficulties in handling, storage, transportation and price. As a raw material, essential in a chemical process to produce rubber, butane acquires new status. When Alden, Trimble and McReynolds[17] describe the probabilities of using propane as the volatility agent for motor fuel, the new trend is plain.

When we debutanize normal blending grades of natural gasoline to obtain additional butane for chemical synthesis, the new base line is at least the value of natural gasoline. Starting with such a base line, the smaller operator can view his butanes as a liquid in a better light than when his only outlet for these components is a competitive fuel market.

In Germany, we are told, butadiene is manufactured by an extremely complicated process. Coal and lime yield carbide; carbide and water yield acetylene; acetylene and water yield acetaldehyde; acetaldehyde and lime yield aldol; aldol and hydrogen yield butyl glycols, and at long last, by a process of catalytic pressure treatment, butyl glycols are converted into butadiene. Of course this long and complicated method is due to the lack of adequate supplies of petroleum and its derivatives.

In our country, so amply provided with petroleum and natural gas, we have many short cuts to butadiene production. Of these shorter methods, the use of butane as the starting agent is certainly the shortest from the standpoint of speeding up the development and production of Buna-S rubber. For this reason, as well as the huge volumes needed for 100-octane gasoline, and other war requirements, it is inconceivable that the use of butane for these purposes will be necessarily restricted because the economics of inequitable returns to the manufacturers of the butanes prevent their concentrating serious attention on the problem of effecting full butane recovery in liquid form. It is conceivable, however, that as the rubber program gathers momentum, it may become imperative that we recover all of the butanes as a liquid from the gas processed, or at least within the limits of the equipment available.

Our prompt attention to what will ultimately be necessary in new plant equipment, utilization of existing idle equipment, or change-over of equipment now operating, together with possibly better operating procedures, even though more costly, will without delay enable us to determine what we will need in economical return to operate under maximum recovery conditions.

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Multicomponent Distillation

Graphical Method for the Estimation of Number of Theoretical Plates as a Function of the Reflux Ratio, Minimum Number of Plates and Minimum Reflux Ratio

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A NEW graphical method is presented by which the curve of O/D v.s. the number of theoretical plates, sufficient accurate for cost estimations, can be obtained when one set of rigid or approximate stepwise calculation data is available. This method makes use of the fact that the function of a multicomponent distillation is the separation of a complex mixture into two fractions. Thus any complex mixture can be considered as a binary mixture of the two fractions to be separated. An equilibrium curve can thus be drawn from the stepwise concentration gradient data. McCabe and Theile's method can then be applied to determine the minimum reflux ratio, minimum number of plates, and number of plates at any reflux ratio.

IN ORDER to arrive at a most economical design of a multicomponent distillation system, one has to obtain a curve of reflux ratio vs. number of theoretical plates. To define this curve, minimum reflux ratio and minimum number of plates at total reflux together with a few points along the curve (i.e., number of theoretical plates required at definite reflux ratios) are necessary. To obtain the minimum number of plates at total reflux, Fenske's equation[2] can be used. For the estimation of minimum reflux ratio, Gilliland's[3] method can be applied. To determine the number of theoretical plates required for a certain definite reflux ratio, Lewis and Matheson's[4] stepwise method is by far the most reliable, though somewhat laborious. In a previous article of this series[9] the author has presented a graphical stepwise method which reduces the manipulation of stepwise calculation to a minimum and eliminates much of the trial-and-error work. For quick results, the author has also presented an approximate method[9] for the estimation of the concentration gradients of each component along the plates with reasonable accuracy. This paper presents a graphical method for determining the number of plates at any reflux ratio, as well as the minimum reflux ratio and minimum number of plates, based on one set of concentration gradient data for a certain definite ratio, which may be obtained either by stepwise method or Shiah's approximate method. The present method, used together with either one of the methods presented by the author in the previous article of this series, enables one to obtain a complete solution to a multicomponent rectification problem with probably the least amount of labor.

In the rectification of complex mixtures, one or two of the components usually can be chosen as the

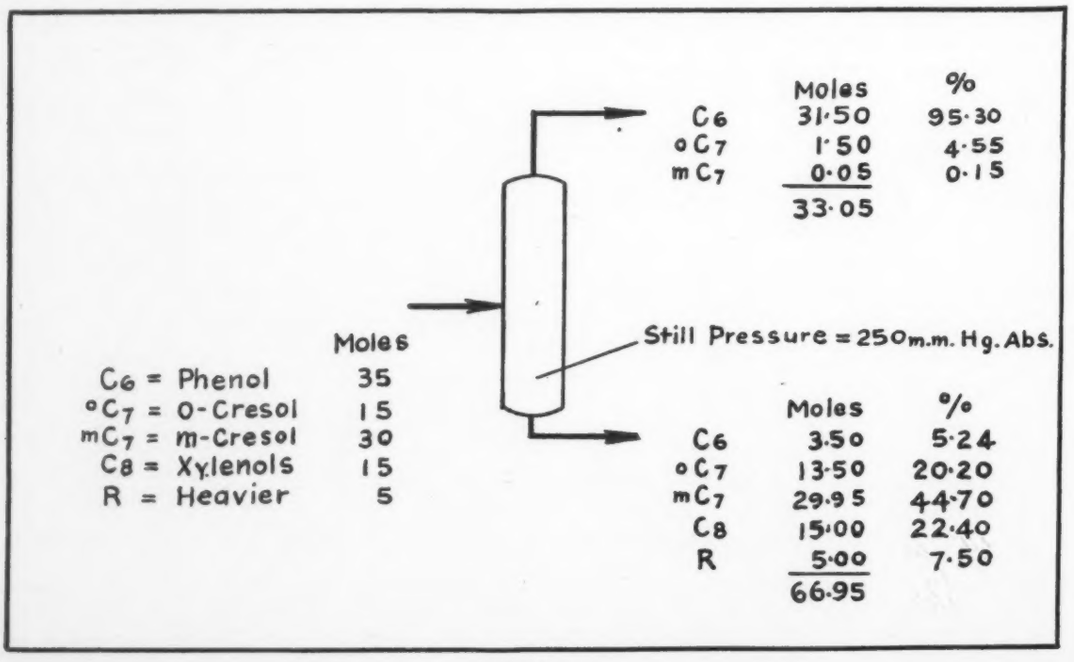

FIGURE 1

key component. Thus the mixture usually can be considered as a binary mixture consisted of a light fraction and a heavy fraction; with the dividing line between them at the key component or components. Considering the two fractions to be separated by rectification as two definite components, McCabe and Thiele's[5] technique can be applied if suitable equilibrium curve could be obtained. Obryadchikov[6] and Peters and Obryadchikov[7] used a single equilibrium curve based on the feed composition; which of course, was in error. Brown and co-workers[1] modified Obryadchikov's method by using an interpolated equilibrium curve based on the composition of a number of plates and apparently satisfactory results were obtained.

However, if we have available one set of rigid or approximate stepwise calculation data for a given reflux ratio, the matter is much simplified. From the stepwise data, the concentration gradients for the key components are known; i.e., values of x_t to x_w for the key components are all known. The so-called operating lines, if the usual simplifying assumption of constant O/V is made, can, of course, be easily constructed. Given the operating lines and values of successive x's for the key component, it is a simple matter to reverse the ordinary McCabe and Thiele's technique to construct the equilibrium curve; i.e., the plot of moles light fraction (or light key component) in liquid vs. that in vapor. For hydrocarbon mixtures the said equilibrium curve is usually a smooth curve, and any unsmoothness near the feed plate can be easily smoothed out. The value of x_f, will, as in the case of binary mixtures, be redetermined at the intersection of the operating lines above and below the feed. It can be seen from the following illustrative example that this readjustment of the feed plate composition will not alter the conclusion drawn by the stepwise method with regard to the number of plates.

When the equilibrium curve is constructed, McCabe and Thiele's method can be conveniently applied for the determination of the number of plates at any reflux ratio, as well as the minimum reflux ratio and minimum number of plates.

Illustrative Example

The tar acid problem solved by Robinson and Gilliland[8] is taken for illustration. The set up of the problem is shown in Figure 1 and the concentration gradient curve obtained by stepwise method is reproduced in Figure 2. From the set up of this problem, it is clear that this complex mixture under investigation can be considered as a binary mixture of phenol and those less volatile than phenol; as the separation desired is that between phenol and the rest. From Figure 2 the mole fraction of phenol in liquid on each plate is read off and tabulated in Table 1.

TABLE 1

Concentration Gradient of Phenol Along the Column

Plate Number	x Phenol	Plate Number	x Phenol
Condenser	0.953	13	0.524
26	0.942	12	0.500
25	0.929	11	0.420
24	0.915	10	0.446
23	0.896	9	0.413
22	0.879	8	0.375
21	0.858	7	0.337
20	0.835	6	0.299
19	0.807	5	0.257
18	0.778	4	0.213
17	0.743	3	0.177
16	0.705	2	0.129
15	0.659	1	0.089
14	0.602	Still	0.052

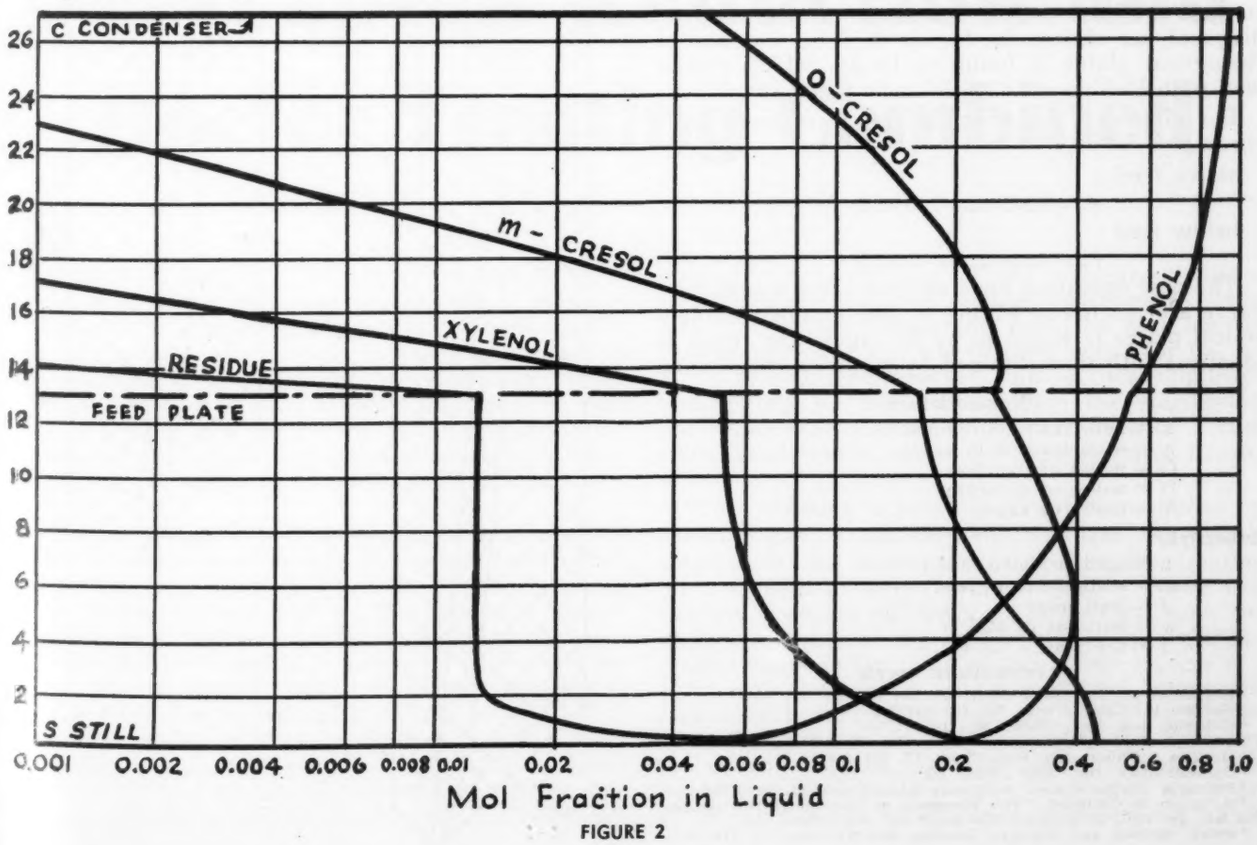

FIGURE 2

The conditions set for the stepwise calculation are as follows:

Above feed:

$$\left(\frac{O}{V_n}\right)=\frac{10}{11} \quad \frac{D}{V_n}=\frac{1}{11}$$

Below feed:

$$\left(\frac{O}{V}\right)_m=\frac{6.43}{5.43}=1.184 \quad \frac{W}{V_m}=\frac{1}{5.43}$$

Hence the operating lines for phenol are, above feed

$$y_n = 0.909\ x_{n+1} + 0.0865$$

Below feed:

$$y_m = 1.184\ x_{m+1} - 0.00965$$

This two operating lines are plotted on Figure 3. A vertical line, $x = x_{n+1}$ is drawn, which cut the operating line at point (x_{n+1}, y_n). From this point, a horizontal line $y = y_n$ is drawn. The intersection of this line with $x = x_n$ gave point (x_n, y_n), which, of course, lies on the equilibrium curve. With a number of similar points thus obtained, a smooth curve is drawn through them which represents the equilibrium curve of mole fraction phenol in liquid vs. mole fraction phenol in vapor for this problem. This curve is shown in Figure 3.

To determine the minimum reflux ratio, a straight line is drawn through (x_D, x_D) and the intersection between $x = x_f$ and the equilibrium curve. The slope O/V is measured, and is found to be 0.848. Hence the minimum reflux ratio is calculated as follows:

$$\left(\frac{O}{D}\right)_{min.}=\frac{\frac{O}{V}}{1-\frac{O}{V}}=\frac{0.848}{0.152}=5.58$$

This checks well with Robinson and Gilliland's figure of 5.6.

The minimum number of plates at total reflux is stepped off between the equilibrium curve and the diagonal, as shown in Figure 3. The number of theoretical plates is found to be 16, which checks well with Robinson and Gilliland's figure of 18.

For O/D = 7, the operating lines are revised accordingly. Thus,

above feed

$$y_n = 0.875\ x_{n+1} + 0.1192$$

below feed

$$y_m = 1.254\ x_{m+1} - 0.01327$$

The new operating lines and the same equilibrium curve are plotted in Figure 4. The number of theoretical plates is found to be 35. Again the result is identical with that obtained by stepwise calculation.

Nomenclature

x = mole fraction in liquid
y = mole fraction in vapor
O = moles of overflow
D = moles of distillate
V = moles of vapor

Subscripts:

n = section above feed
m = section below feed
f = feed plate
w = bottoms of still
t = top plate

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[7] Peters & Obryadchikov, Neftyanoe Khozyaistvo **24**, 50 (1933).
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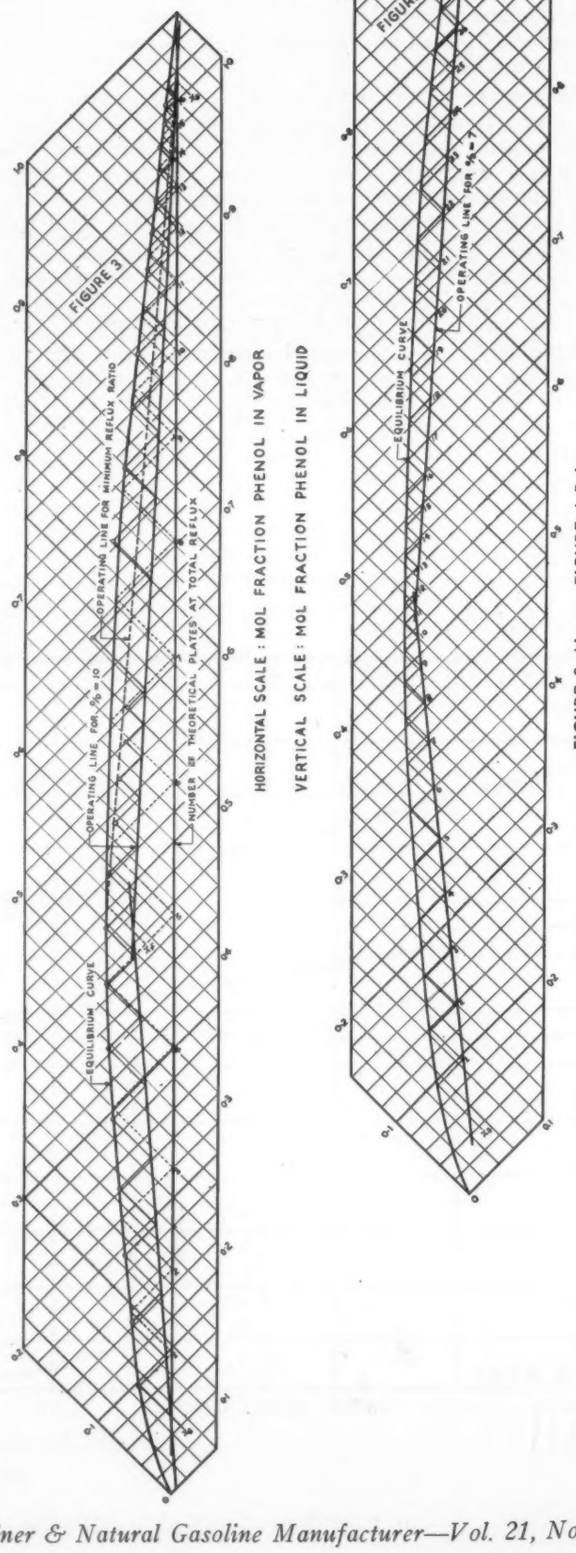
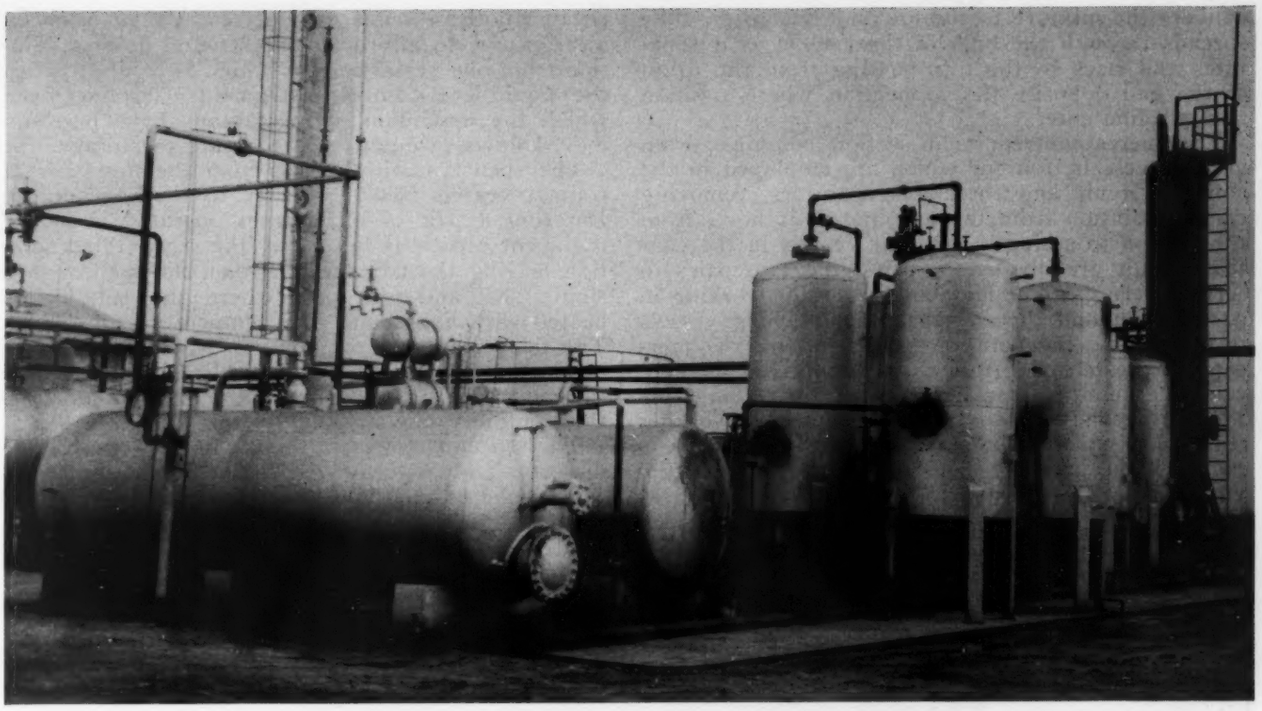


FIGURE 3
OPERATING LINE FOR MINIMUM REFLUX RATIO
OPERATING LINE FOR O/D = 10
NUMBER OF THEORETICAL PLATES AT TOTAL REFLUX
EQUILIBRIUM CURVE
HORIZONTAL SCALE: MOL FRACTION PHENOL IN VAPOR
VERTICAL SCALE: MOL FRACTION PHENOL IN LIQUID
FIGURE 4
EQUILIBRIUM CURVE
OPERATING LINE FOR O/D = 7

FIGURE 3 Above—FIGURE 4 Below



Contact vessels for hydrogen sulfide removal and reduction of mercaptans are at the right with the caustic regeneration tower in the left background.

Mercaptan Reduction and Doctor Treating Combined

DOCTOR treatment for the conversion of mercaptans to disulphides, and preparation of pressure distillate by reduction of sulphur compounds at minimum expense with caustic in the first contact is being given greater thought by refiners generally. Among the independent refiners who employ both doctor solution and caustic for treating pressure distillate successfully is Caminol Company, with refining plants at Santa Fe Springs and Hanford, California.

The percentage of mercaptans in the pressure distillate produced in the Santa Fe Springs plant varies as to the type of stock available for the cracking plant, and may run as high as .45 when heavy topped crude is used. If gas oil and kerosene, either as such, or as a blend of varying proportions is the charging stock, the mercaptan content of the pressure distillate is much lower, averaging around .15.

In the refinery at Santa Fe Springs, the raw pressure distillate is stabilized to a Reid vapor pressure between 10 and 11 pounds, where most of the hydrogen sulphide is removed in the stabilizer overhead discard. The first part of the pressure-distillate-treating plant is in two sections operating in series and continuously, beginning with the first contact between gasoline and the treating agent for the removal of hydrogen sulphide. This section is followed immediately by the second where the mercaptans are reduced an average of 65 percent with a constant circulation of continuously regenerated caustic solution.

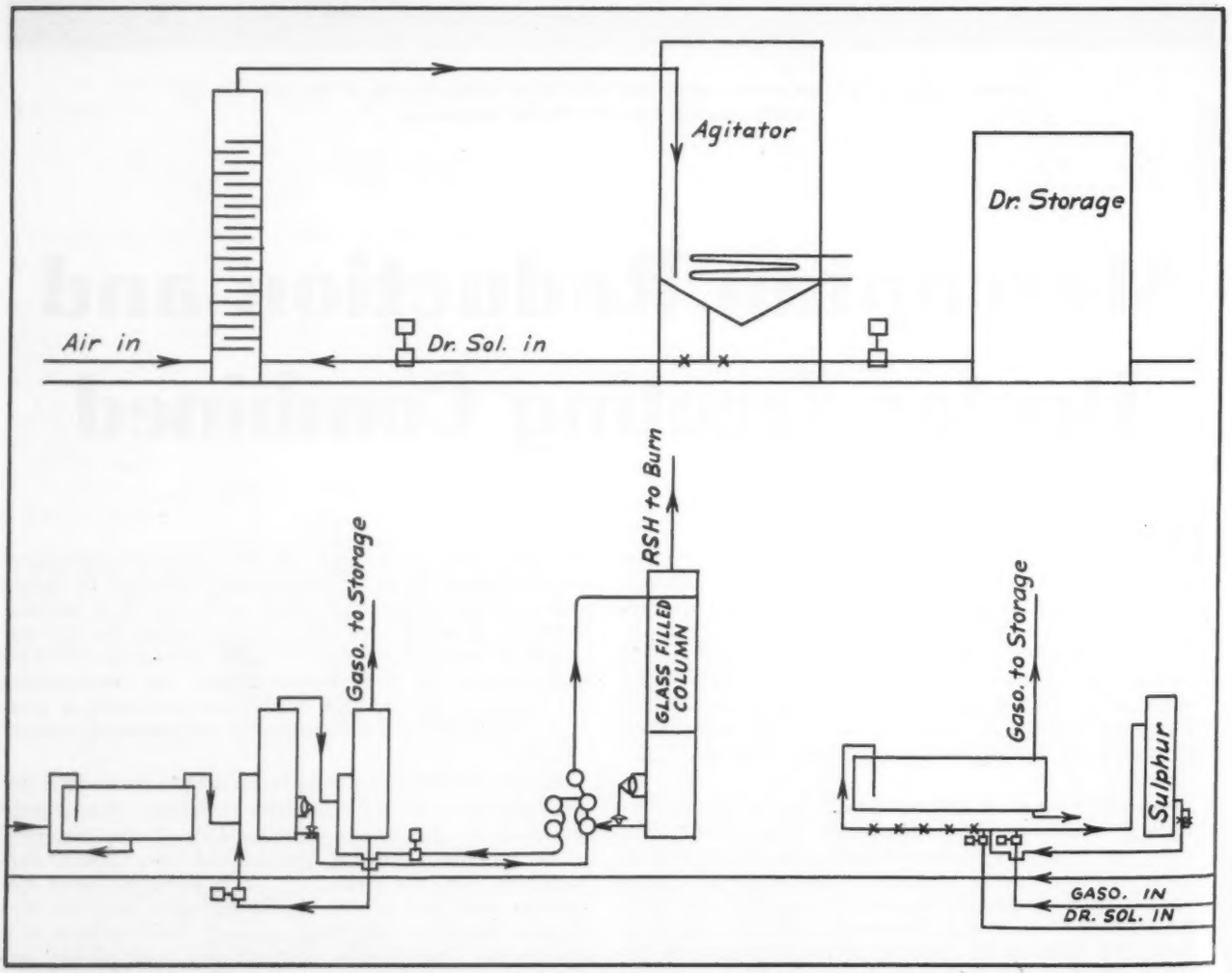
When treating a pressure distillate produced by cracking gas oil and kerosene distillate, the caustic solution in the mercaptan section of the treating plant is held at a Be. gravity of 18°. When this solution loses its efficiency, it is dumped from the system and part of the liquid pumped into the hydrogen sulphide stripping section. This section is a horizontal drum with connections and piping arranged with an eductor type tee which withdraws the solution from the lowest side of the drum by the velocity of the gasoline passing through the instrument. Both gasoline and caustic enter the drum at the top through an extension of the piping which

delivers the mixture to the low side where gasoline spreads through the bulk of the caustic as it separates and rises to the top, passing from the drum at the end opposite the connection where solution and gasoline enter.

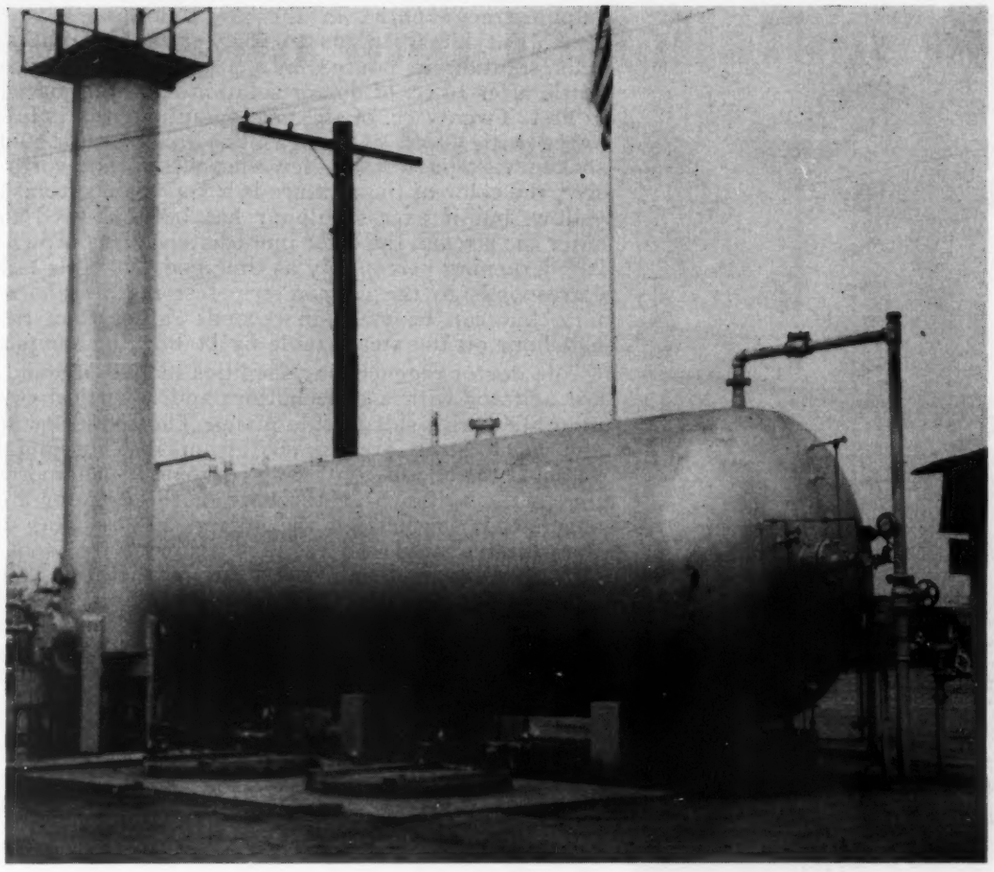
The mercaptan-reduction section contains seven vertical vessels, four of which are employed in the contact circuit and three as separators, removing caustic solution from the gasoline as it flows from the section to storage. The four vessels in the contact circuit are divided in pairs, the two pairs in series in the gasoline flow, and each pair working in parallel. Beyond the contact and scrubbing vessels is the caustic regeneration system where the mercaptans are released from the solution. Regenerated caustic is pumped from the regenerator cooling side to the second pair of contact vessels, working through a set of turbulence forming tees and passing with the pressure distillate to the vessels, from which it is withdrawn by a pump and passed backwards to the first set of contact vessels. Meeting the hydrogen-free pressure distillate, the partially spent caustic breaks the edge of the mercaptans in the gasoline, and is removed through a single level controller from both vessels. This is accomplished because both vessels are connected at their bases by a large pipe to afford an unrestricted flow of solution from one vessel to that which is equipped with the liquid-level-control instrument. Gasoline from which the maximum of mercaptans have been removed flows through the separators to storage.

The spent caustic flowing from the first pair of contact vessels passes directly to the regenerator. Entering a pair of exchangers operated in series, the spent caustic is heated by the regenerated solution leaving the column, and then flows through a single shell-and-tube unit where the solution is heated with live steam to a temperature of 240° F. The temperature of the solution leaving the heater is constant as the steam is controlled by a recording thermostat with the control point in the line carrythe solution to the stripping tower.

The stripping tower in this section is 36 inches in diameter and 20 feet high with a 5-foot liquid section at the base. Above this section is a perforated plate carrying a live steam coil, perforated, to be used when required for processing the solution. The next 10 feet above this perforated plate is filled with chunks of broken glass averaging in size to a soft ball, which comes from dumpings of a glass factory.



Arrangement of the Treating Unit is in the Lower Part of the Diagram, with hydrogen sulfide Removal in the First Tank at the Left. The next two Horizontal Vessels Are for Reduction of Mercaptan Content with Caustic Solution. Following this are the Water Cooler, Caustic Coolers, Heat Exchangers and Preheater with Mercaptan Scrubber at the Right. The Horizontal Vessel at the Lower Right is the Receiver for Doctor Solution with Contact and Turbulence Forming Equipment in the Header Below and the Sulphur Tower at Right. The Regeneration Unit is in the Upper Part of the Diagram with the Air Blowing Tower for Regeneration of Doctor Solution at the Left, Agitator in the Right Center Followed by the Storage Tank for Regenerated Solution.



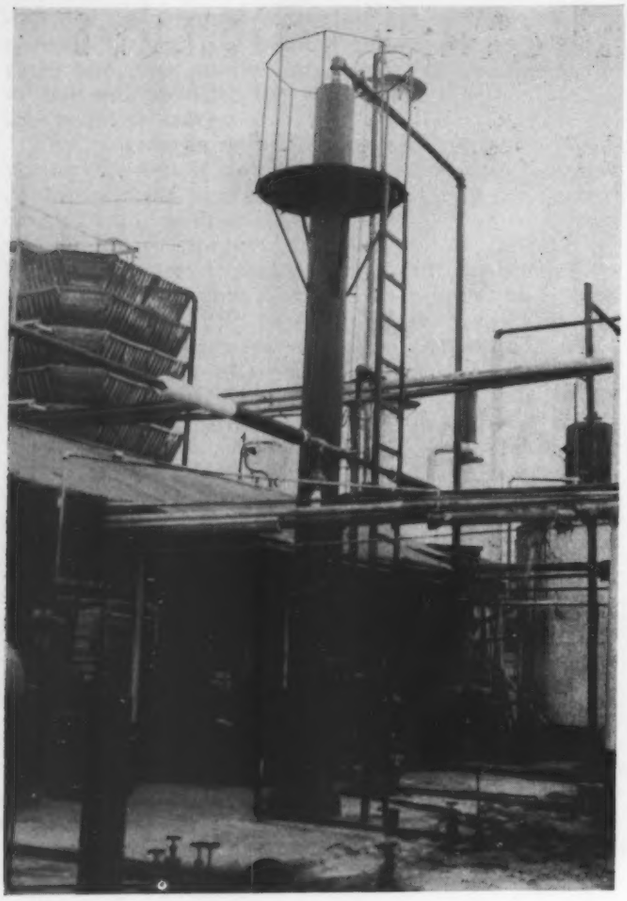
Sulphur Column Left and Doctor Solution Receiving Drum.

Covering this section is another perforated plate upon which rests the distribution spider carrying the hot caustic from the steam preheater. In most cases, the process steam at the base of the column is not necessary to strip the solution of the mercaptides, as the distribution of the liquid over the glass releases the sulphur compound effectively. Mercaptans and steam pass overhead to the stacks of the cracking plant where they are burned.

The solution leaving the column passes through a liquid-level controlled valve, flowing countercurrent to the foul solution from the contactors, and pass immediately to two shell-and-tube exchangers in which water is circulated to reduce the temperature to an average of 90° F. Flowing back to the contact columns by the use of a pump, the caustic solution completes the cycle, and is used in this manner until it loses its effectiveness for the removal of mercaptans from the pressure distillate. The gravity of the solution is maintained to a constant 18° Be. by the introduction of fresh water in the stream from the coolers. The water is fed through a valve in the water line which is set to provide the required amount of make-up. Since the temperature of the solution to the regenerating column is constant, and the quantity remains at 22 gallons per minute at 10 pounds, gauge, pressure in the column, the evaporation of water from the caustic solution is constant also, and when once set, the gravity of the solution back to the contactors does not vary appreciably. The amount of water evaporated from the solution is such that the gravity rises from 18° Be. at the contactors, to 22° Be. at the outlet of the regeneration column. This severe regeneration is satisfactory at this plant and is desired because the high heat and rapid evaporation of water effectively converts the sodium mercaptides to mercaptans, providing a highly efficient solution for contact with the pressure distillate in the contact vessels.

After the pretreatment with caustic, the pressure distillate flows to a receiving, or run tank from which it is pumped for doctor treatment. This operation usually is carried on in daylight with the rate sufficient to handle all gasoline produced during 24 hours of run from the stills. The doctor plant in the gasoline to chemical contact contains a horizontal vessel and a vertical sulphur drum. The gasoline is boosted from the run tanks with a motor-driven centrifugal pump which delivers the gasoline to the reciprocating gasoline pump at the treating plant, which in turn passes it to the contactors beside the receiving drum. The manifold in the gasoline line is provided with a by-pass line to supply the sulphur drum with gasoline sufficient to dissolve the stick sulphur and to provide means of returning the sulphur-laden gasoline back to the contacting equipment.

Doctor solution is withdrawn from the regenerated supply tank with a steam pump which is connected with piping to the contact manifold downstream from the entrance of the gasoline. Between the connection delivering the gasoline and that delivering the doctor solution to the contact manifold is the line which permits sulphur-laden gasoline to blend with the stream. The quantity of gasoline from the sulphur drum is controlled with a harp manifold on the side of the sulphur drum to permit the desired quantity of sulphur to effect the required break in treating. Gasoline and doctor solution flow through the various contactors and turbulence valves to the



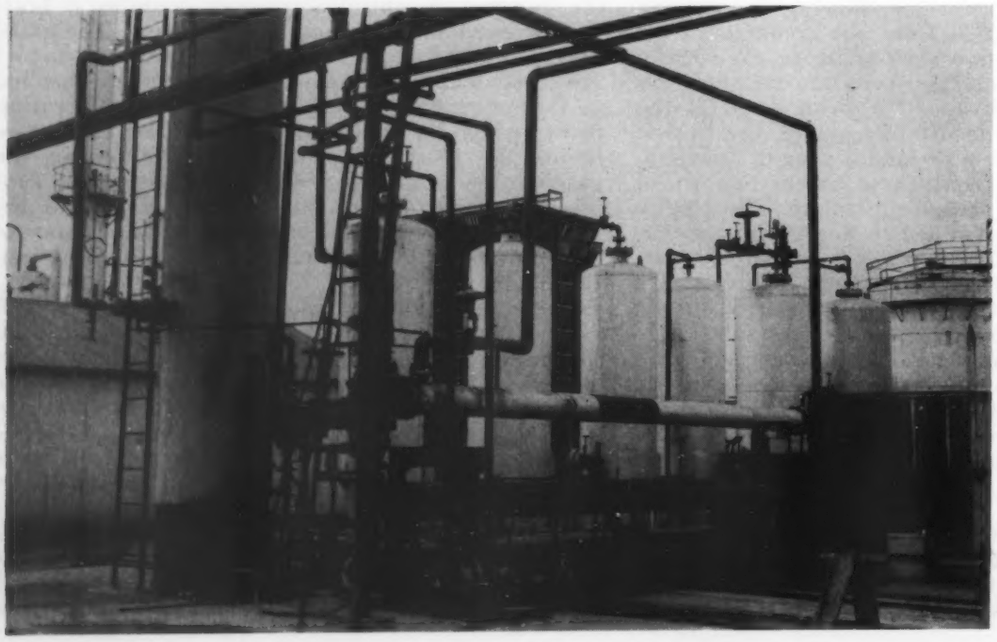
Side-to-Side Pans in the Tower Permit Violent Blowing Spent Doctor Solution with Air in the Regeneration Procedure

horizontal drum which retains the doctor but from which the gasoline flows to water wash.

Tests are conducted frequently during the day by the treater using the standard doctor test to indicate whether or not the gasoline is sweet. Check tests are made with a solution of mercaptans and sulphur-free naphtha in the proportion of 1 part of N. Butyl mercaptans to 1500 parts of naphtha. This solution is poured into a standard 4 ounce bottle after 10 cc. of doctor solution has been placed in first. Twenty cc. of the mercaptan-naphtha is followed with 30 cc. of the gasoline to be tested and shaken vigorously for a few seconds. If non-corrosive, the color of the mixture is a very pale greenish yellow, but if excess sulphur has been allowed to enter the stream, the color immediately turns brownish, darkening perceptibly as time goes on. This test corresponds to the copper strip test in the laboratory, but can be made in seconds rather than the half hour on the steam table by boiling the sample.

The doctor-regenerating facilities include a standard agitator with a cone bottom and a vertical column filled with side-to-side plates. The spent doctor and black strap are pumped from the horizontal vessel at the doctor-contacting equipment each morning to the agitator. In the base of the agitator are steam coils for heating the doctor, and remains in the agitator until the required temperature is obtained. When sufficiently hot for regeneration, the doctor is pumped to the vertical column, entering at the base on one side, with compressed air at 100 pounds, gauge, entering through a 2-inch line on the other side. Circulated in this manner, the doctor solution and air pass from the top of the column to the agitator where an inside line—looking down—delivers both the air and the doctor to a point well below the top of the liquid. A double purpose is offered for this practice. One to prevent undue spraying and loss of the solution, and the other to provide extra air contact in the mass of doctor in the agitator.

The doctor solution which is regenerated in this manner requires from 8 to 10 hours recirculation and blowing with air to bring it to the quality required for treating the pressure distillate. After regeneration, the doctor is pumped from the agitator to a steel storage vessel until such time that the treating plant requires the chemical mixture for contacting the gasoline pumped from the mercaptan scrubber run-down tank.



Heat Exchangers, Preheater and Regenerated Caustic Solution Cooler at Base of Mercaptan Cooler

Design and Installation of Steel Tank Bottoms by Arc Welding

E. G. WOOLMAN
Cities Service Oil Company

CURRENT world conditions have required an increased output of new products from refineries, but since the necessary iron and steel has been restricted, it is very important that all tanks with corroded bottoms be returned to service. By using new or second-hand steel, this method to be discussed has proven to be very satisfactory.

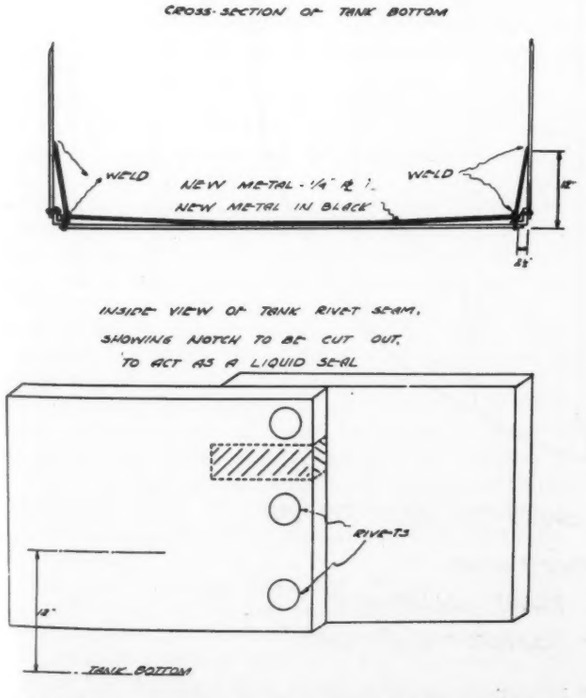
In reconditioning tanks, safety must be given first consideration in order to protect both men and materials. Tanks which have contained lighter petroleum fractions are more dangerous, but are more easily cleaned. Those containing heavier oils must be thoroughly cleaned. Steaming is the accepted method of removing the bulk of the oils, followed by application and removal of fullers earth applied to the bottom. These two steps result in a dry gas-free tank.

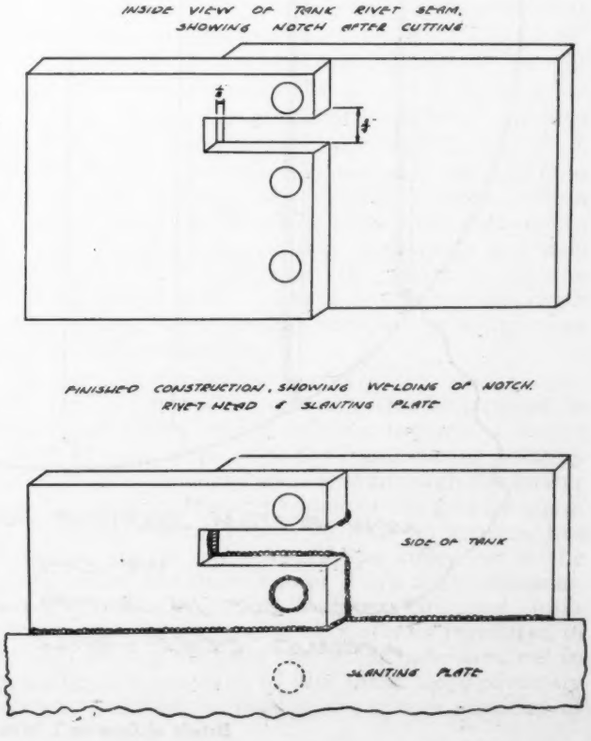
In order that the steel may be placed in the tank, a slit 6 feet by 6 inches wide is cut close to the bottom of the tank. This serves as door sheet, saving the cost, time, and labor of removing a side plate. Sheet steel to form the bottom is cut from standard widths 3/16- or 1/4-inch plate. Drawing 2 will illustrate how a notch must be cut in the end of each bottom sheet. The sheets fit together, being lap-welded throughout most of the length. The notch length at the end of each sheet is butt-welded to the adjoining one so that a flat surface will be formed around the edge.

Completely around the edge of the bottom is welded a slanting plate about 12 inches wide. The top of the slanting plate rests on the side of the tank. The base rests on the flat section of the tank bottom. Drawing 1 shows the cross section view of a tank with a new bottom and the relationship of the new steel with the old.

To prevent any oil from seeping in back of slanting plate and running between new and old bottom, a method of notching the up-and-down seams has been devised. This is shown in detail in Drawing 1. It is very important that the up-and-down seams above the slanting plate be notched and welded.

The new bottom must be welded with the back-step method throughout, also welding bottom complete before adding slanting plate. After slanting

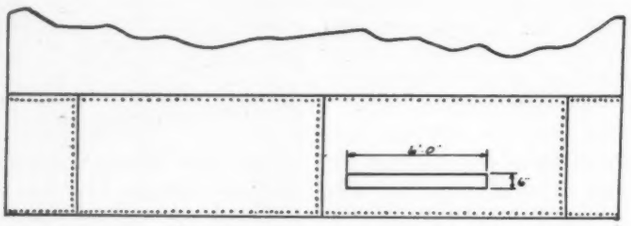



INSIDE VIEW OF TANK RIVET SEAM,
SHOWING NOTCH AFTER CUTTING
FINISHED CONSTRUCTION, SHOWING WELDING OF NOTCH,
RIVET HEAD & SLANTING PLATE
SIDE OF TANK
SLANTING PLATE

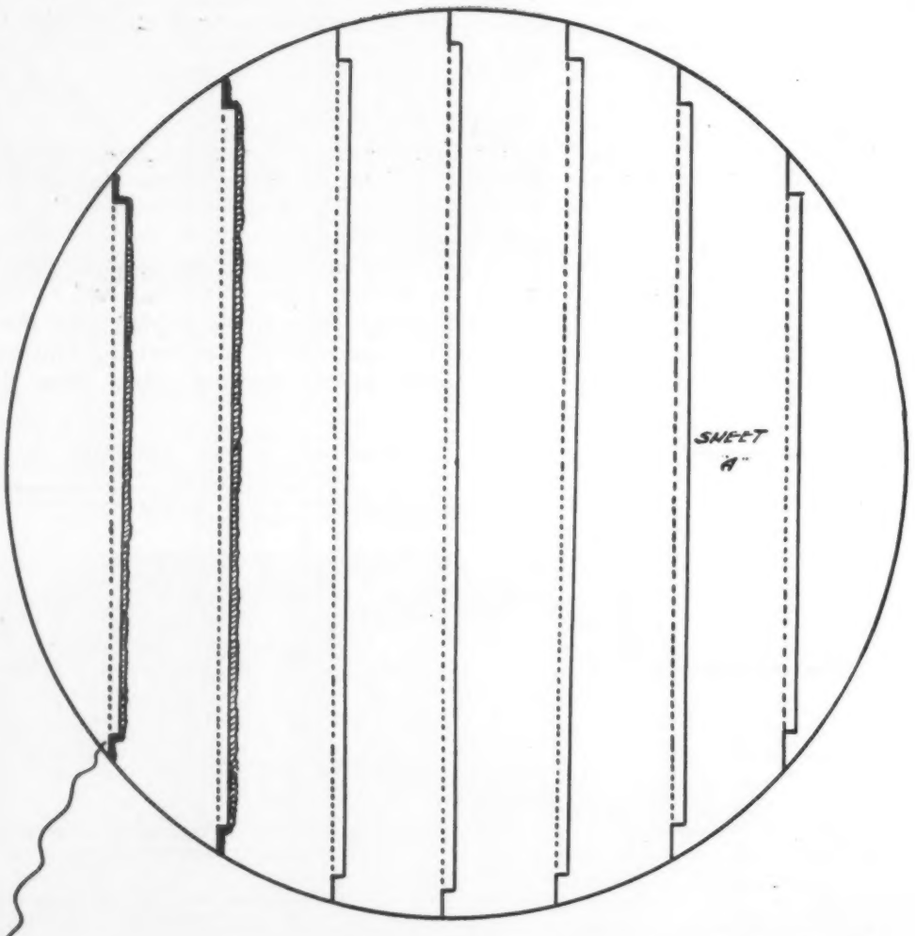
Details of Drawing 1 as Referred to in the Article are on this Page.

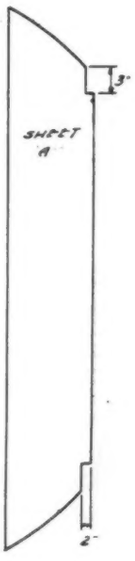
plates have been tacked in place completely around the tank, then welding bottom of slanting plate to tank bottom first, then top of plate to shell. When first vertical seam has been reached, this is welded before continuing. Follow this method throughout. This procedure will let slanting plate creep, which in turn will prevent locked stresses in vertical seams.

This method of installation has been used on many tanks and has proven to be successful in each case. On a 1250-barrel tank, the cost of insulation, labor, and material is about $575.00; a saving of $300 over an installation of a new riveted tank bottom may be realized. A much shorter time is required to complete the job.



SIDE OF TANK, SHOWING SECTION TO BE CUT OUT TAKING PLACE OF DOOR SHEET

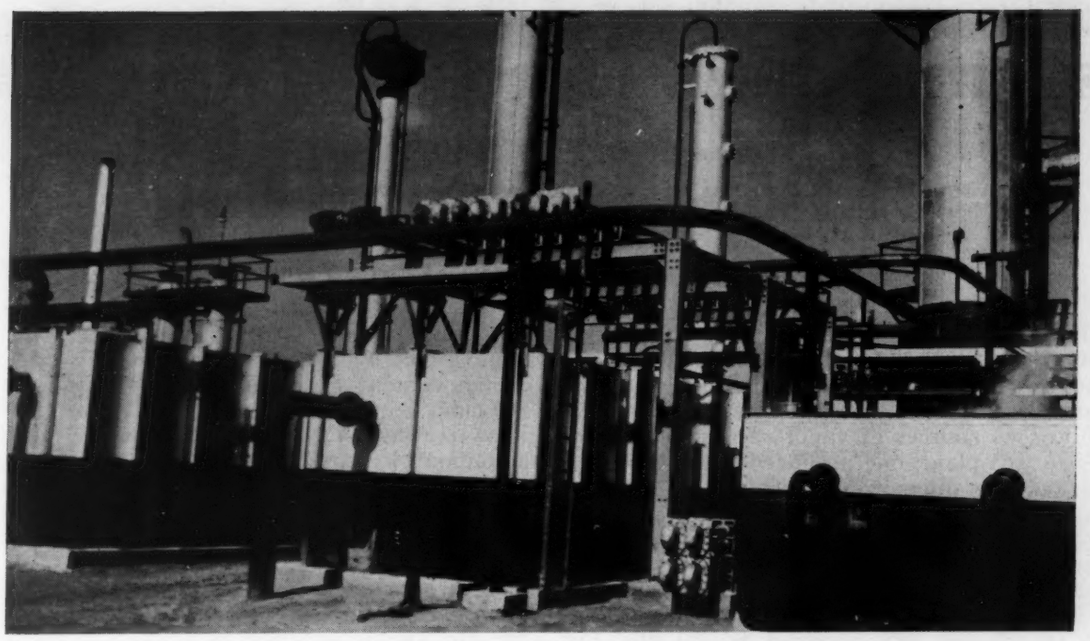




NEW BOTTOM, SHOWING HOW SHEETS ARE TO BE WELDED TOGETHER.
NOTCH CUT IN SHEET, SO THAT SURFACE AROUND EDGE WILL BE SMOOTH, & FLAT.

All illustrations Courtesy Hobart Brothers Company

Details of Drawing 2, With Sheet A of the Tank at the Right.



Heat Exchange Allows Increase In Cracking Unit Charge

By installing heat exchangers in its cracking plant at Wilmington, California, Fletcher Oil Company has been able to substantially increase daily throughput. This has been accomplished without a material increase in fuel consumption or increasing the input of heat in the furnace tubes.

The original design of the Dubbs unit was for cracking kerosine distillate, and vessels and other equipment were fabricated to withstand the high temperatures and pressures required to break down this refractory material. Due to changing conditions, the plant has been operated on several charging stocks, running through kerosine distillate, gas oil, topped crude and fresh crude. Fresh crude has been the principal stock pumped to the still, and steps have been taken to increase the charging rate above the amount for which the plant was designed, and to increase the efficiency of the plant as a whole.

One of the latest additions to cracking facilities consists of two sets of heat exchangers. One is mounted on the vapor condenser box and employed as a vapor-to-charge exchanger, which has resulted in recovering waste heat, and reducing the quantity of water for cooling and condensing the pressure distillate vapors.

In the crude charge flow, the second set of exchangers is mounted on low concrete piers beside the residuum coolers, and is connected to the flow piping with a manifold which provides for bypassing the exchanger or routing the crude charge from the vapor exchanger to the exchanger handling the residuum to recover waste heat at this point.

Since installation of these exchangers, the charge, when cracking crude oil, averages between 350 and 360° F., instead of the usual temperature prevailing on the crude storage, averaging between 75 and 80° F. An increase in temperature of 240° F. on the charge entering the main fractionating column has resulted in raising the temperature of the combined feed at the base, from an average of 620° F. to 650° F. This higher temperature has made it necessary to pump a larger quantity of reflux back to the column to control the end point of the pressure distillate, but has been an advantage in that the vapors and partially fractionated liquids on the plates above the vapor inlet have been cut to a better product, with less gums and has a greater response to subsequent treatment for sweetening.

Because of the higher temperature of the combined feed, an increased quantity can be pumped to the furnace tubes, which in turn requires a larger amount of crude pumped to the fractionating column. The velocity of the combined feed through the heater tubes has been increased because of the greater quantity of stocks being processed, but no erosion has been indicated in the ends of the tubes or in the headers when the plant comes down for a cleanout, averaging about once in 60 days. This and other improvements in the operating methods instituted in the plant during the past two years have resulted in increasing the capacity of the plant approximately 60 percent without increasing the size or capacity of any of the major units.

Instrumentation Improves Operation Of Polymerization Unit

A YIELD of 90.12 gallons of polymer gasoline per pound of catalyst has been obtained by the Pathfinder Petroleum Company in its refinery at Los Alamitos, California, with a UOP non-regenerative type unit. Two sources of vapors are employed for the feed to this plant, one produced when gas oil is cracked and the other when kerosene distillate is used as the charge to the cracking plant. Both the olefin content and sulphur content of the two gases differ and require changes in the operating routine.

The high yield of polymer gasoline came between June 1 and November 17, 1941. Approximately 3000 pounds of catalyst are required to fill the two columns, and this produced in excess of 270,000 gallons of sweet polymer gasoline.

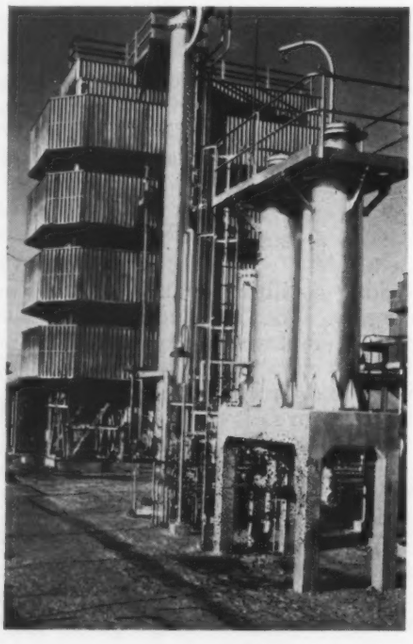
So far as the operation of the catalytic plant is concerned, the temperatures and pressures are conventional. Instrumentation, however, has been extended beyond the average plant and includes recorders which show the quantity of raw feed, the quantity of recycle gas returned to the plant and the quantity of combined feed entering the unit. Frequent tests are made of the combined feed and the tail gases, the results of which are made a basis for controlling the olefin content of the combined feed, which is held between 18 and 20 percent.

When the cracking plant is operated with gas oil as the charging stock, the stabilizer vapors carry an olefin content of 29 to 31 percent, and the sulphur compounds average 747 grains per 100 cubic feet. On kerosene distillate, higher temperatures produce vapors containing between 32 and 35 percent olefins and sulphur content runs as low as 475 grains per 100 cubic feet.

To obtain the feed to the polymerization plant, the pressure distillate is stabilized down to an average of 7 pounds RVP to remove all olefins from the commodity which also carries a substantial quantity of butanes. This overhead vapor stream is directed to the polymerization plant for processing. The first step in the polymerization plant is a thorough scrubbing with a solution of caustic soda which removes the hydrogen sulphide and lowers the mercaptan content to an average of 0.0002 grains per 100 cubic feet.

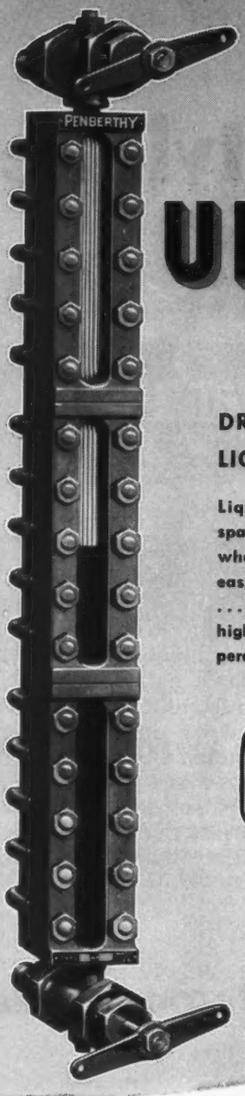
In treating, this gas passes from the stabilizer to a column 24 inches in diameter by 30 feet high containing 2 sections of Raschig rings in 10-foot beds. The quantity of caustic solution employed for the scrubbing charge varies between 275 and 300 gallons, which is made up to a gravity to suit conditions and the particular gas being treated. For gas oil vapors, the solution is started off with a gravity of 22° Be. and is effective as a treating agent for 24 hours, adequately removing the sulphur content of the vapors until it is approximately 75 percent spent. Experiments plus experience show that a charge of this concentration can be dumped at 8 o'clock each morning and a new batch used for replacement. When the vapors are produced from kerosene distillate, a like quantity of solution is made up, but the concentration is either 16° or 20° Be. The weaker solution is effective for a 24-hour run, but the 20° solution can be used for 48 hours.

The solution, most of which is contained in a horizontal surge tank at the base of the scrubbing column, is circulated over the top of the tower by a duplex steam pump. The solution travels to the base of the column where the outlet is higher than the connection on the surge tank, and the vapors pass from the overhead to a small separator to remove any solution which may have passed from the tower, and prevent liquids from entering the compressor which boosts the pressure on the gases to that required for operating the catalytic columns.



The polymerized material leaving the columns together with hydrocarbons not affected by the catalyst are fractionated to produce a 10-pound RVP, polymer gasoline. Butanes are condensed and blended back with the pressure distillate to raise the vapor pressure from the 7 pounds at the pressure distillate stabilizer to 10 pounds in the blending tanks.

QUALITY UNCOMPROMISED



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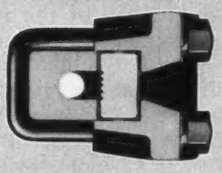
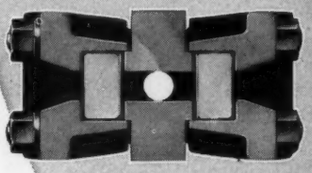
DROP FORGED STEEL LIQUID LEVEL GAGES

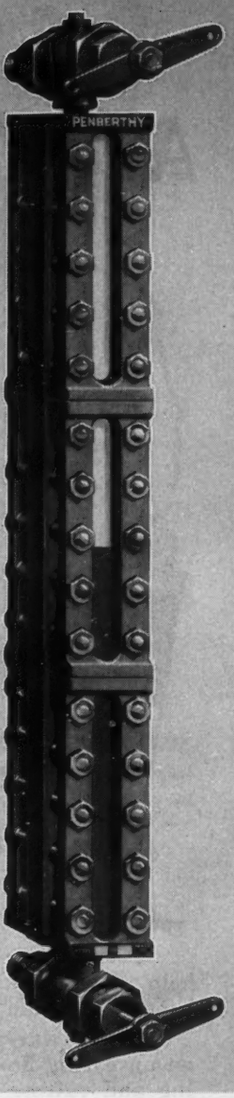
Liquid shows black—empty space shows white. Preferred wherever liquid level must be easily and positively visible . . . and when liquids are under high pressure or at high temperature.



PENBERTHY
Transparent
DROP FORGED STEEL LIQUID LEVEL GAGES

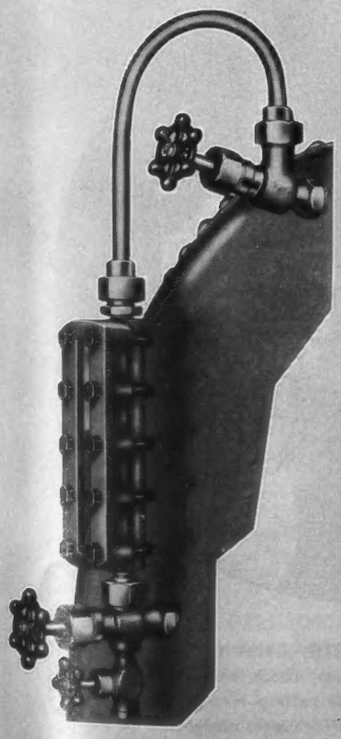
Used to observe color and density of liquids under high pressures, and/or temperatures. Construction is exceptionally rugged . . . similar to Reflex types.





Penberthy Liquid Level Gages

ALL PENBERTHY GAGES CONFORM WITH A. P. I.—A. S. M. E. REQUIREMENTS



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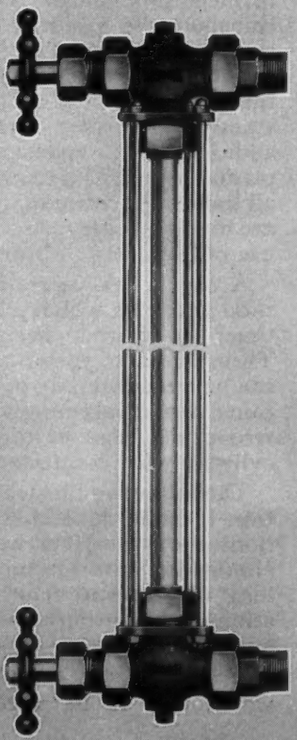
WATER GAGE SET

Water shows black—steam shows white. U-bolt construction is strongest and simplest to service. Glass replaced by simply removing nuts on face of gage . . . unnecessary to work between gage and boiler.



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Made of Chromium-molybdenum alloy temperature-resisting steel, extra heavy throughout. Stainless steel trimmed. Tubular glass type gages also available in various other metals suitable for practically all conditions.

PENBERTHY INJECTOR CO.

DETROIT, MICHIGAN • Canadian Plant: Windsor, Ontario

PENBERTHY PRODUCTS

Are You Wasting Oxyacetylene?

Pyramiding Demand Makes Strictest Conservation Essential War Effort

G. V. SLOTTMAN, Air Reduction Sales Company

IT IS almost inevitable that in the rapid expansion of oxyacetylene welding and cutting, there should be a period when wasteful practices are prevalent. Furthermore, the wholesale addition of thousands of inexperienced operators has considerably aggravated this condition. There is no question that the conscientious welder or cutting operator is concerned about eliminating waste, when he knows its source. This article, therefore, is intended to serve as a "check-list" that will help all concerned in preventing a serious oxygen supply situation from becoming critical.

Keeping war production industries supplied with an unceasing flow of oxygen and acetylene for welding and cutting is no less essential than providing the metals needed for production. Demand for these gases has increased enormously. For some time, gas manufacturers have been hampered in their efforts to meet this demand by a shortage of cylinders to transport the gases. Now, there has arisen another source of concern. The oxygen production capacity of the oxyacetylene industry is being strained to the fullest extent, in attempting to keep abreast of constantly pyramiding oxygen requirements. In spite of additions and expansions of oxygen and acetylene plants, a critical situation faces this industry — and all industries consuming these gases — unless efforts are made by everyone to conserve, particularly in the use of oxygen.

A survey has revealed a considerable number of shop practices which might be disregarded in peacetime, but which today must be considered wasteful. These habits of yesterday, being largely unconscious, can be remedied only by a re-evaluation of the significance of such seemingly trivial practices as using the wrong size hose or torch tip, or opening up a full cylinder when a quarter-full cylinder stands idle.

The following illustrated list of recommended practices is based upon observations of correctable conditions in oxyacetylene welding and cutting shops. The elimination of wasteful practices will not only go a long way toward relieving the "tight" oxygen situation, and insuring an uninterrupted supply of gases, but will also prove economical to the individual shop where such conditions prevail. One shop, for example, was found to be unconsciously wasting approximately 25 percent of its oxygen consumption, through an accumulation of "insignificant" losses.

Essentially these suggestions involve but one basic concept — to uproot yesterday's habits to meet today's demand. None of the recommendations is difficult to accomplish, provided we open our eyes to every-day practices which should no longer be tolerated. Industry needs many waste wardens; they may be unofficial, they may be self-appointed, but if they watch out for wasteful practices among themselves and their co-workers they will be performing a very real service.

Recommended

USE PROPER SIZE TORCH TIP. Check tip size, an oversize tip wastes gas. If number is not clear, check with cleaning drill. A No. 2 tip used instead of a No. 1 for cutting ½-inch plate consumes 10 to 20 percent more oxygen, 16 percent more acetylene—all wasted.

DON'T LET TORCHES BURN WHEN NOT IN USE. It may seem troublesome to be constantly relighting the torch, but if it burns idly for even as little as 3 minutes out of each hour, it is wasting 5 percent of its gas consumption. Five percent of last year's industrial oxygen consumption would be 360 million cubic feet. Don't waste it, use these 1,636,000 tankfuls for welding and cutting.

CLOSE CYLINDER VALVES WHEN TORCH NOT IN USE. Between jobs, release regulator screw to prevent loss of gas through hose leakage. If only the torch valves are closed, gas pressure in the hose rises and may force leaks. If leaks are already present or if new leaks are forced, considerable gas will be lost.

Practices for Conserving Oxyacetylene

(Continued on next page)

CHECK HOSE PERIODICALLY FOR LEAKS. Dip hose in water while under pressure. Leaks may be infinitesimal, but a 1/64-inch diameter leak in hose operating at 100 pounds will waste 290 cubic feet of oxygen in 24 hours — more than a tankful. Soap and water will reveal leaks at connections.

DO NOT USE EXCESSIVE PRESSURES. Watch your pressure, excessive pressure wastes oxygen. Keep pressure chart handy, and use it. This, one of the most common malpractices, is usually done by inexperienced operators who believe they thereby get a more efficient flame, or to save a trip to the pressure chart. Manufacturer's rated pressures, based on long experience, are the most efficient for average conditions. When more speed is desired, new high speed machine cutting tips cut faster without consuming additional oxygen.

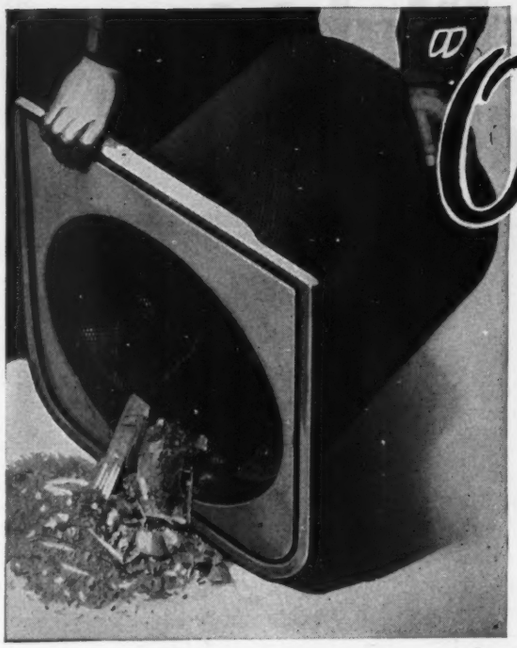
Practices for Conserving Oxyacetylene *(Continued from preceding page)*

KEEP CYLINDER INVENTORIES LOW. The old custom of keeping plenty of reserve cylinders must be abandoned, for it "freezes" them at a time when rapid turnover is imperative. Order fewer cylinders at a time, and order oftener. Use every cylinder for all it is worth before disconnecting it. Return empty cylinders promptly, others may need them. Don't abuse cylinders, a damaged cylinder must be taken out of circulation. It contributes nothing while undergoing repairs.

USE CORRECT LENGTH AND DIAMETER HOSE. Long hose is cumbersome and requires more pressure. Extra lengths get unnecessary wear, invite leaks. Hose that is two small in diameter for the job requires higher gauge pressure to secure sufficient flow, causing unnecessary strain and promoting leakage in the hose.

KEEP TIPS CLEAN AND FREE FROM CARBON AND SLAG. An unclean tip is inefficient, wastes times and gas. Keep cleaning drills handy, and use them. Congested orifices nullify the value of using proper pressures and speeds, resulting in lower efficiency and consequent waste of gas.

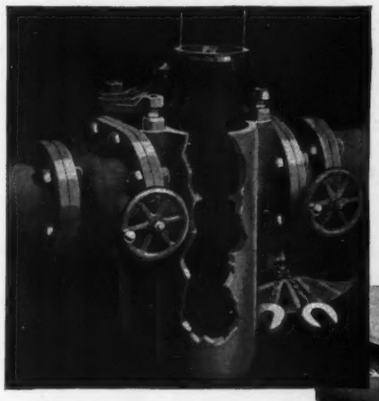
HANDLE HOSE WITH CARE. Because hose is made of rubber, it is most important that it be made to last as long as possible. To ensure this, it must be protected against mistreatment which promotes leaks. Therefore; keep hose out of range of hot oxide and sparks; wash off oil and grease, which ruin rubber; place a plank on each side of the hose where it crosses truck runways; store any hose stocks in a cool, dark place; and when a hose is damaged, cut out the bad portion and splice the ends together with standard splicing nipples.



"Out with trouble!" SAY ELLIOTT STRAINERS

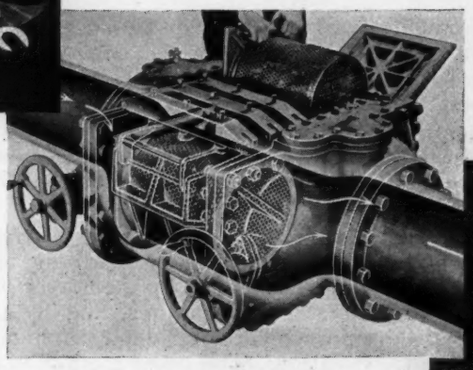
They guard the pipe lines. They protect liquid-handling equipment of all types and kinds from the dangerous sabotage of debris, dirt and foreign matter. They halt trouble in the making, prevent delays and breakage in production equipment, make maintenance a minor chore instead of a cause for nervous breakdown — for it's far easier to dump an Elliott strainer basket than to clean a heat exchanger or repair a pump. Elliott strainers are the Guardians of Production — and they never sleep.

Check with Elliott engineers on how to meet your straining problem.



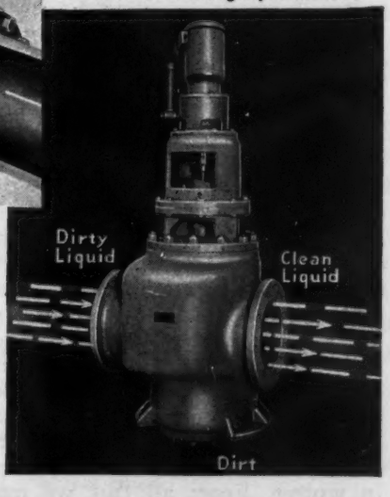
For OIL

Particularly for lubricating and fuel oil lines. A development of the famous Twin Strainer, with strainer basket of proper mesh for its purpose. Cleaned manually, without interruption of service. Available in two types, from 1 in. to 12 in. pipe size, and up to 300 lb. working pressure.



For WATER

Twin Strainers always have one side in operation while the other is shut off and available for cleaning. Made in a variety of types for all needs, and in sizes 2 in. to 42 in. For any working pressure up to 150 lbs. Also single strainers where occasional shutdown for cleaning is permissable.



For SELF-CLEANING Service

The Elliott Self-Cleaning Strainer requires only occasional routine supervision. Continuous backflow automatically flushes out foreign matter. Valuable in removing large quantities of relatively fine dirt, where manual cleaning would be too frequent. Made in sizes from 4 in. to 24 in., and for pressures to 125 lb. gauge.

A-269

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SAFETY may be considered from many angles. Those who write on this subject tell of the various hazards found in the industries and they also tell of the types of men who are prone to accidents. They tell of the men who are opposed to society in general, of the men who resent authority, and of the men who habitually meet with accidents. It is interesting and informative to read how accident hazards are eliminated and how men are educated to practice and to observe safety rulings.

It is established that "accidents do not happen; they are caused," and that "accidents are preventable." It is claimed by some that accidents are caused by ignorance and selfishness. Keeping in mind that the employer spends large sums of money to safeguard machinery and tools, and to make working conditions safe and to educate his employes in the practice of safety, we still find that men either hurt themselves or are hurt by those with whom they work.

Of course each industry has accident hazards peculiar to itself, but generally speaking, whether it is building a bridge, digging a tunnel, office work or factory work, the farm or in the home, we find a great similarity of accidents. The same accidents to the hands and to the feet, to the head and to the eyes, the same sprained backs and hernias. We find infection in the chemical industry, the ammunition industry and in the home. We find there are seasonable accidents, in the summer the days are longer and hotter, in the winter the days are shorter, darker and colder. Blood poisoning and heat prostrations prevail in summer, scalds, burns and falls prevail in winter. From all this we may conclude that accidents are caused by hazards, or a combination of hazards plus the negligence of the individual. It would be ideal if the human factor in an accident could be trained or disciplined to work safely in any industry under any seasonable condition.

An injury to person is an evil thing. It is cumulative in its harm. It causes pain and suffering and expense to the injured one. It causes anxiety and economic loss to his dependents, to the community and to his employer. It behooves wage earners to realize there is a moral obligation involved in keeping a job. To keep oneself mentally alert and physically well is essential in any endeavor, to conserve and to protect the employers' interests is a worthy ambition. The development and the exercise of these traits lend themselves to meritorious attention on the part of the employer to the ultimate benefit of the employe. The problems of the wage earner are wages, working conditions and living conditions, and not anything on this earth will enable him to overcome or to better these conditions but the development of his physical, mental and spiritual character traits, plus the knowledge and the skill needed for his particular job.

There are two methods of teaching safety. One by instilling fear of an accident as by the horror pictures or illustrations, and by the enforcement of penalty for rule violations. The other method is by repeated reminders, through lectures or teaching, of the harmful results due to an accident. The teaching of safe operation of machinery and the safe use of tools and the observance of safety rulings is the mechanical feature. It is also necessary to teach the spiritual features of safety, and that is to arouse and to stimulate the traits of fairmindedness and loyalty. It appears that if in the teaching of safety it be firmly impressed upon the individual, his obligation to society, his obligation to those who love him and are dependent upon him, his obligation to his employer and to those with whom he works, then his instinct to do right will inspire him to greater efforts not to hurt himself or those with whom he works.

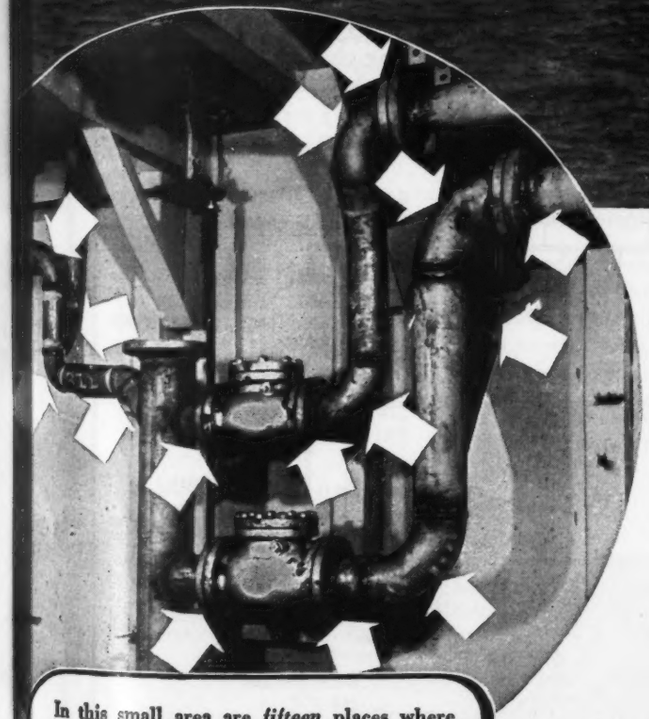
Whole volumes can be written about the excuses given for accidents. I have seen the result of many self-imposed injuries and injuries caused by others, and I am firmly convinced that the reasons for these injuries are as stated by the National Safety Council, namely: "I didn't see," "I didn't hear," "I didn't think." Where it is obvious that "that which is caused to happen" is not an accident, it would appear that if the employer of labor will do away with the word "accident" and call the injury what it really is, either a self-imposed injury or an injury caused by others, the psychological effect will immediately bring about a reduction of so-called accidents.

In 1940 accidental death overtook 96,500 persons and accidental injury struck 9,100,000 men, women and children. We say, "What a tragedy" and we dismiss it lightly by saying, "caused by accident." Talk with the undertaker, talk to the hospital interne, talk to the sheriff and to the police chief and to the fire chief and you will find out what caused this, and do not be surprised to find out that intoxication is not the cause.

I have never known it to fail that the first remark of the injured person is, "I forgot myself." For the sake of argument let us agree that this is so, then I should like to say to this person, "what right have you by this momentary forgetfulness to bring sorrow and concern to your friends—what right have you by this momentary absentmindedness to deprive those who are dependent upon you of your earning capacity; what right have you by this momentary negligence to bring concern and expense to your employer?"

There are no "spills" at piping turns when TUBE-TURN fittings are on the job!

- ACME PHOTO



In this small area are *fifteen* places where Tube-Turn welding fittings and flanges are on the job—giving full protection against leakage and other maintenance worries. In any complete piping system, figure the hundreds of points where flow direction changes, and you'll see why Tube-Turn returns, elbows, tees, reducers, laterals, nipples, caps and flanges offer extra protection and trouble-free piping.

Disaster at the turns is an old story—

With spray flying and motors roaring, speed boats hurtle around the buoy-marked racing turns at break-neck speed! Cutting the curves too sharp or too fast means an upset—another case of failure at the turns.

The same danger lies at turns in *piping systems.* Wherever there is a change in flow direction, the strain imposed by the flow speed and pressure increases the probability of leakage and failure unless they're *welded* and *protected* with Tube-Turn welding fittings!

Write for helpful Tube-Turn data book and catalog.

TUBE-TURNS, INC., Louisville, Ky. *Branch offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Tulsa, Houston, Los Angeles. *Distributors in all principal cities.*

TUBE-TURN TRADE MARK — The FIRST WELDING FITTINGS 1ST AND STILL THE BEST — *Welding Fittings*

The Testing of High-Pressure Gases

C. H. GEE
LaGloria Corporation

In making this report[1] it seems to me some historical data should precede the account of recent comparative gas tests along the Gulf Coast in order that the succession of events leading up to the work will be clear.

About a year ago the N.G.A.A. Gas Testing Committee extended its studies to include high-pressure gases and began to plan a rather extensive program of research on several pressing problems in distillate operations. Much of this work was a natural corollary to previous work on low-pressure gases where standard test methods for determining content, specific gravity, sulphur, volume, etc., had been established.

Among the problems which were considered of primary importance in the high pressure gas studies were:

1. Development of standard methods for sampling and testing of gases.
2. Development of standard methods of high pressure gas measurement.
3. Study of high pressure gas transmission.
4. Study of sub-surface flow conditions.
5. Development of methods for removing salt and hydrogen from gases.
6. Study of liquid entrainment in high-pressure gas streams.
7. Development of a standard method for determining specific gravity of raw gases.

Since it was conceded very little progress could be made on the whole project until the answers to the first two problems were obtained, it was deemed necessary to make a survey of all methods then in use for obtaining a representative sample from a high-pressure distillate well and the methods used for determining the liquid content of the gases. Accordingly, H. L. Oder, Cities Service Oil Company, chairman of the committee, was assigned the job of making this survey at association expense and his voluminous report is a fine testimonial to his ability and thoroughness. He spent five weeks touring the distillate fields of Texas and Louisiana and talking with technical men and operators. His very complete report was used for planning a direct attack on the problems.

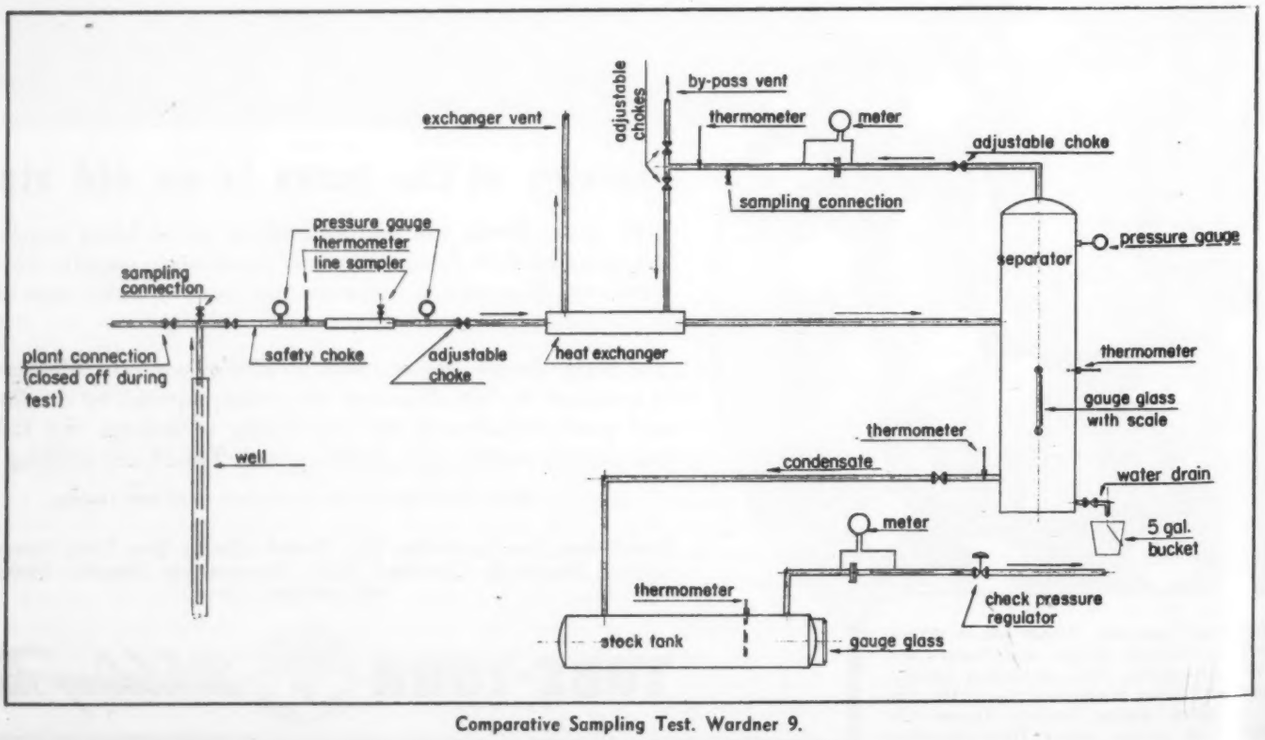
At about this same time, the American Recycling Association, under the leadership of E. E. DeBack, Corpus Christi Corporation, and Professor R. L. Peurifoy, Texas A & I College, was planning much the same type of program. Last fall discussions between executives of that new organization and those of the N.G.A.A. brought a consolidation of the two groups and resulted in the formation of the High-Pressure Gas Division of the N.G.A.A. At special meetings in Houston and Dallas, the representatives of this division laid the plans for beginning the program right after the first of the year. The death of Mr. DeBack and changes in personnel brought about by the war delayed the program, however, and it was not until March this year that plans for field testing were actually completed.

In the meantime, the Divisional Technical Committee, under the chairmanship of E. O. Bennett, Continental Oil Company, had decided the best approach to the problem of supercompressibility factors and orifice-meter measurement of high-pressure gases was to hire the best available talent to correlate all existing data on the subject and present a recommendation for standardization. The committee discussed the problem with Dr. D. L. Katz, University of Michigan, who agreed to undertake the study provided member companies would make available for his use certain field data required to substantiate his theoretical determinations. These arrangements were satisfactorily completed and the first report on this phase of the project is to be presented at this convention by Dr. Katz.[2]

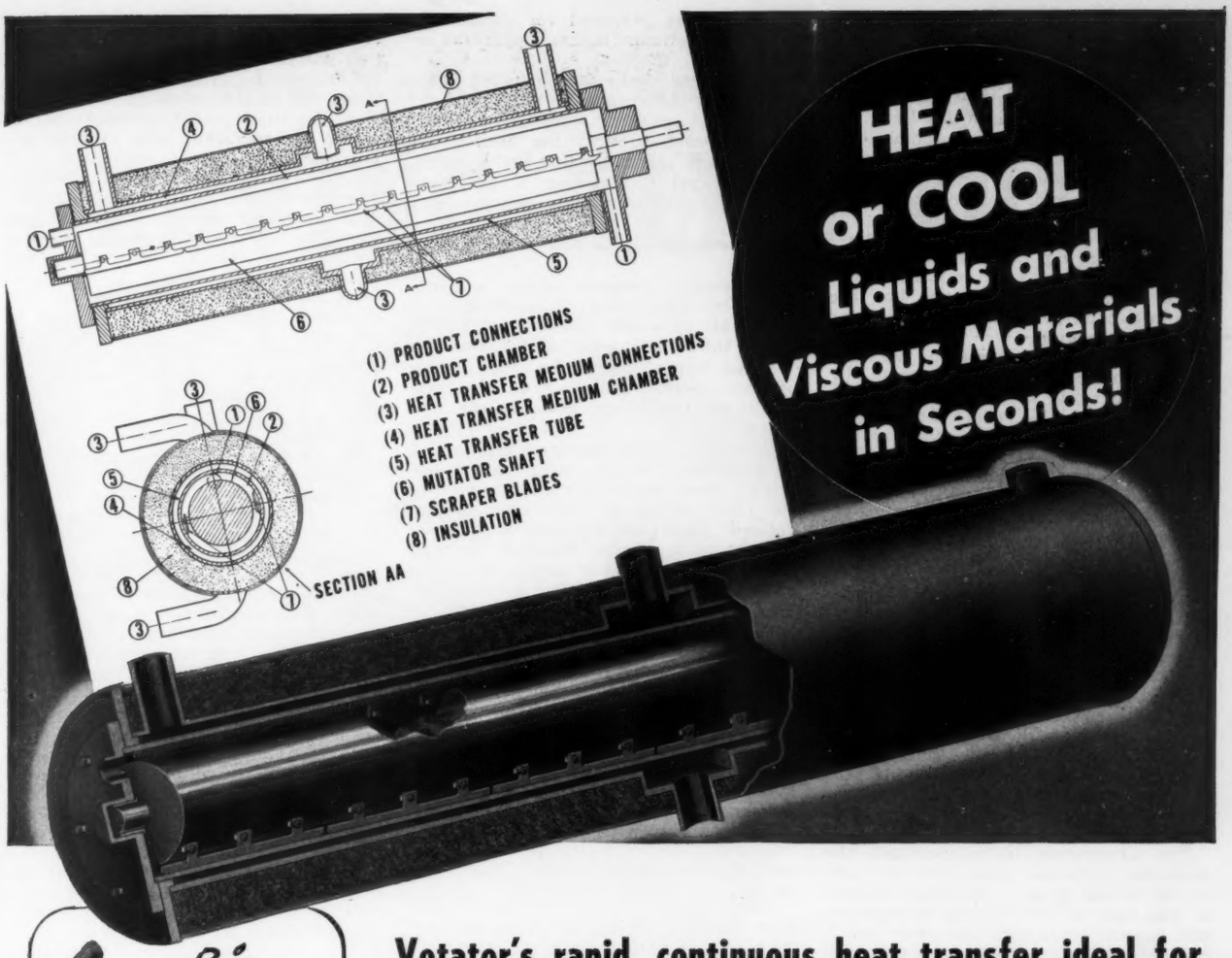
Returning now to the recent field

[1] Before the 21st Annual Convention Natural Gasoline Association of America, May 14-15, 1940, Mayo Hotel, Tulsa, Oklahoma.

[2] See page 64.



Comparative Sampling Test. Wardner 9.



6 Big Advantages

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SIMULTANEOUS MIXING, EMULSIFYING or AERATING

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Votator's rapid, continuous heat transfer ideal for oil products, synthetic rubber, plastics, chemicals!

For instantaneous, uniform heat transfer at lowered costs, nothing can compare with the Votator. Remarkable efficiency is attained as a very thin film of the product is continuously passed over a relatively large heat transfer surface. THIS PERMITS HEATING OR COOLING IN SECONDS. Accurate, uniform temperatures are maintained constantly.

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tests—the purpose of the work was to compare the results obtained by the several different and widely used devices for obtaining a representative sample of gas from a distillate well when all were testing the same gas from the same well under identical conditions. All results were then to be compared with those obtained by a full-scale separation in a high-pressure separator. The whole program calls for a repetition of the series in several areas on gases of varying content and at different pressures. The recently completed field comparisons are but the first in a planned series of four in the Gulf Coast region.

The actual field equipment was arranged and mostly strong-armed by Herald Oder. He was assisted by J. M. Stanford, James Grimshaw and W. R. Brown of Chicago Corporation, and J. C. Birdsall, Lockhart Petroleum Corporation, and the committee is highly appreciative of their efforts. The equipment was so laid out as to permit testing by all the various types of testing devices. Every company and laboratory having such equipment was invited to participate in the work. Each was notified as to the dates of the series, April 13 to 17, and the place, the Wardner 9 well of Chicago Corporation near Kingsville, Texas. Each was requested to make tests with their standard equipment without revealing their results to anyone but Herald Oder who was in complete charge of the series. The devices of 4 oil companies and 4 laboratories were tested and 14 oil companies took active part in the proceedings.

The association in general and the divisional technical committee in particular wishes to give its official thanks at this time to the testing laboratories and supply companies for their much appreciated and valuable cooperation in this test series. Without the assistance of Henderson Engineering Laboratories, Alice, Texas; Parks Laboratories, Inc., Houston; and E. W. Saybolt & Company, Houston, the research program would not have been possible. Messrs. Henderson, Parks and Sandberg, respective representatives of these companies, gave unstintingly of their time and counsel. Our especial thanks are due to G. O. Kimmell and to his company, Black, Sivalls & Bryson, the former for his valuable advice on general procedure and his personal assistance at the well, and to the latter for its generous loan of some of the principal parts of the equipment set up at the well. Other supply houses which loaned equipment were Refinery Supply Company and Westcott & Greis, Inc.

Dr. Frank Dotterweich, Texas A & I College, Kingsville, and Dr. Sidney Born, Tulsa University, also supplied valuable advice and equipment for which the committee was very grateful.

Specifically the equipment at the well was as follows: Wardner 9 had the customary type of Christmas tree found on many condensate wells, two wing valves off the tubing connection with the casing connected to one side. However, the well was normally produced only through the tubing. The well was already equipped for the introduction of a sampling nozzle into the tubing.

Arrangement of Piping

Connections from one side of the tubing to the meter were removed and this side was prepared for connection to the full stream testing apparatus as follows:

1. A safety choke was installed large enough to offer only a minimum resistance to ordinary flowing rates but which would prevent the well from "going wild" should a line break occur.
2. A nipple containing a pressure-gauge connection and a thermometer well.
3. Provision for a flow-line-sampling device.
4. Another pressure gauge connection. This gauge together with the one in (2) above would determine the drop across the sampling device in (3) above.
5. An adjustable choke, the setting of which determined the producing rate of the expanding gas going to the separator.

With this arrangement of piping and by switching the two wing valves, the tubing flow could be turned either to the plant or to the test apparatus as desired. Such an arrangement is important as it permits flowing the well continuously and thus avoids the troublesome delays of waiting for a previously shut-in well to stabilize itself.

The partly expanded gas then flowed through one side of a heat exchanger to the separator, which was operated at about 900 pounds pressure. Two suggestions as to the best operating pressure were received, one was for 800 pounds, and the other for 1000 pounds. Nine hundred pounds was chosen as a compromise between the two. A head exchanger was provided to lower the temperature of the flowing gas in the separator since this temperature without the exchanger would have been in excess of 90°F.

The separator was 1000-pound-pressure capacity, 30 inches in diameter and 13 feet high. The float and dump valve mechanism was removed and the separator carefully measured by liquid volume between the levels indicated by two marks on the ends of a scale which had been cemented to the gauge glass. A narrow strip of mirror was also cemented to the gauge glass to help avoid the effect of parallax in reading the liquid level. By timing the producing interval between the lower and upper marking on the scale an accurate rate of liquid production could be determined.

A thermometer in a well on a level with the top gauge glass connection was used to determine the gas temperature, and another thermometer in a well in the liquid outlet gave the temperature of the condensate. Separator pressure could be determined from an indicating pressure gauge and also from a recording gauge.

Condensate was throttled from the separator to the stock tank through a ¼-inch needle valve. A 1-inch shutoff was provided ahead of the ¼-inch valve so that the latter might be removed for cleaning, if any obstruction should occur. Water produced was drained from the separator through a similar arrangement of valves into a 5-gallon cylindrical bucket. A cylindrical bucket facilitated water measurement, which was done by gauging the depth with a rule. The separator gauge glass was arranged to secure condensate samples at separator pressure.

The stripped gas passed from the separator through an adjustable choke set to hold the desired separator pressure, and expanded through a 4-inch (3.816-inch ID) high-pressure-meter setting where it was measured. Adjustable chokes on the meter outlet maintained about 400 pounds pressure on the meter. Four hundred pounds pressure for the meter measurement was chosen as a compromise, since gas measured at the separator pressure—900 pounds—would have introduced a large and questionable deviation factor, while measurement at near atmospheric pressure would have resulted in freezing temperatures in the setting. It also would have required a meter run of large diameter to measure the flow at low pressure.

Since high-pressure-meter outlets expanding to atmospheric pressure may freeze off, such meter settings should be built to withstand the maximum separator pressure.

A thermometer well near the meter outlet was provided to determine measurement temperatures and a gas-sampling connection was also located at this point.

Gas flowing from the high-pressure-meter setting divided and expanded through two adjustable chokes, one of which vented directly to the air, while the other expanded part of the stream through the low-pressure side of the heat exchanger. Proper regulation of these chokes controlled both the pressure in the meter and the temperature in the separator.

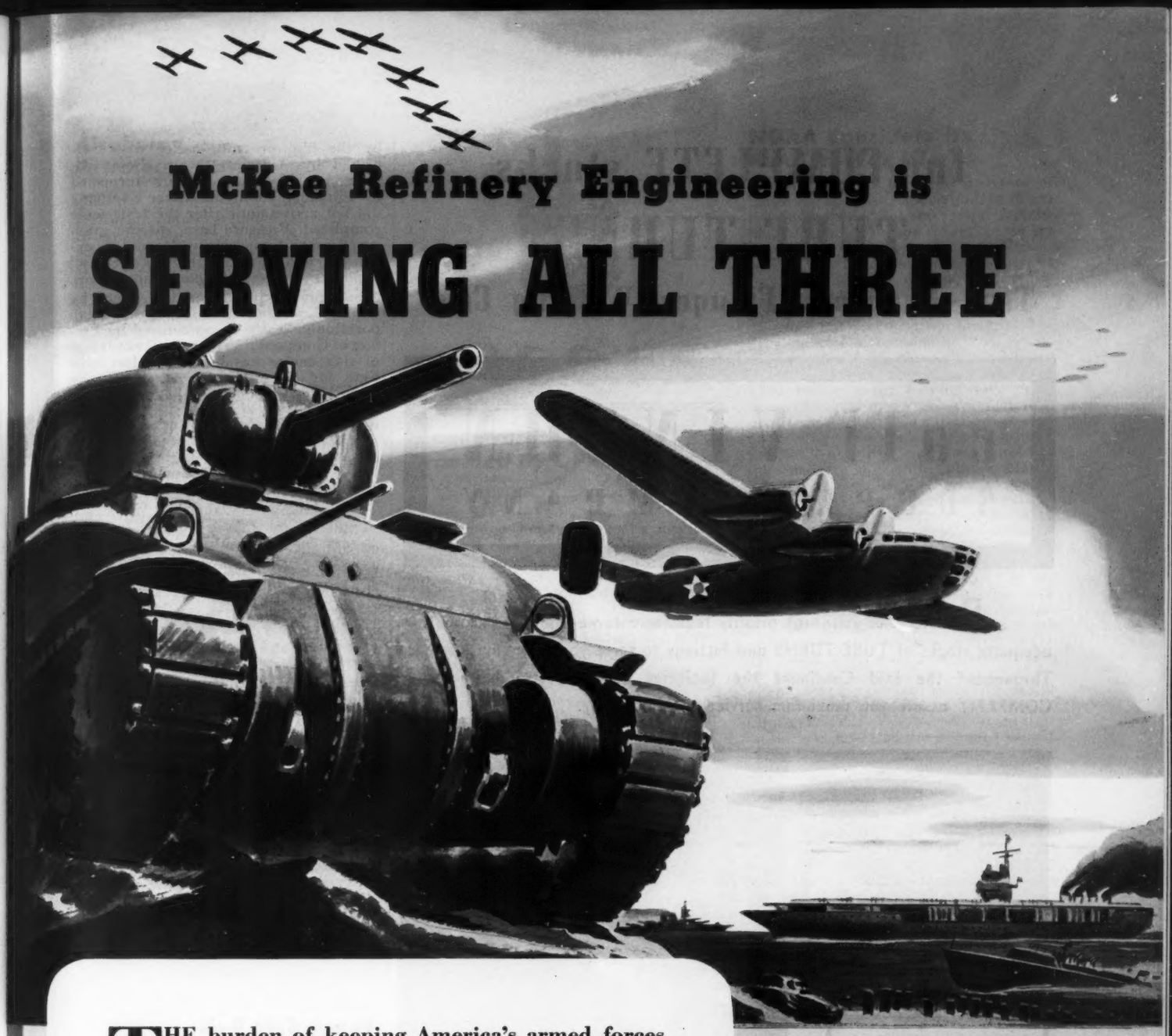
Separated condensate expanded to a 4 by 20-foot horizontal stock tank where the net volume could be gauged. A deep thermometer well through the top of the tank to a point near the tank bottom provided means for securing condensate temperatures. The vapor vented to the air through a 2-inch meter setting with a check pressure regulator on the meter outlet.

Obviously, definite and final conclusions should not be drawn from a preliminary set of comparative tests, and this association will have made reasonable progress if it has learned how a second set of tests should be conducted. To avoid the possibility of erroneous conclusions being made at this time the results of the tests, pending further study, are reported in such a manner as not to identify the various testing devices.

In the following tabulation the arbitrary numbers 1 to 7 inclusive designate the results obtained by the various test devices. The letters "FS", meaning full stream, indicate the corresponding results of the full-stream apparatus. The ratios were determined by dividing the respective test results by the corresponding full-stream results—Ratio A and the average of the later results—Ratio B.

Test	Net Content	Ratio "A"	Ratio "B"
No. 1	.602	1.095	1.095
F.S.	.550		
No. 2	.673	1.191	1.224
F.S.	.565		
No. 3	.555	.995	1.009
F.S.	.558		
No. 4	.636	1.156	1.156
F.S.	.550		
No. 5	.563	1.093	1.024
F.S.	.515		
No. 6	.527	.958	.958
F.S.	.550		
No. 7	.644	1.140	1.170
F.S.	.565		

The orifice meter base factors used for calculating gas volumes measured



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by the high-pressure meter were furnished by American Meter Company, Erie, Pa. The base factors furnished by Pittsburg Equitable Meter Company did not arrive until after the tests were completed. Pressure base, specific gravity, flowing temperature, Reynolds, expansion and deviation factors were all applied in the gas-volume computations.

Specific gravities were determined by two balances as well as by a small portable indicator manufactured by Permutit Company. While another design of this device has been used for some time for the measurement of CO_2 in other industries, its use for specific gravities in the oil industry is relatively new. Results obtained on gas at this well were entirely satisfactory and the committee wishes to thank F. M. Poole, Poole Engineering Company, Dallas, for his cooperation.

For laboratory analysis, four gas samples were taken from the downstream end of the orifice-meter setting and four condensate samples were taken from the separator at separator pressure. The results of these analyses are not yet available.

Of necessity this is largely a progress report and more complete data will not be available for some months yet. Present plans call for continuance of the test series throughout the summer, if the war does not interfere, and the committee should have some conclusions ready early in the fall.

One point on which the committee wishes to be entirely clear is that anyone who has a testing device or method is perfectly welcome to take part in our program. Observers are also welcome and we will be glad to send notices of when and where tests are to be held to anyone desiring this information. For the time being most of the collected data is for the committee and participating laboratories only but a complete report will be made later.

Texas Sets Rules For Cycling Plants

Control of cycling operations in Texas, is provided in a new railroad commission order effective July 1. Under the new program, each plant must have a "certificate of compliance" good for 12 months only, and unless this certificate is in effect, no tenders will be issued for production from the plant. Special forms are provided and require measurement of gas taken into the plant. Gas used for various purposes must be measured separately.

Separate tanks are required for liquid oil condensate, or other hydrocarbons taken into or extracted by these plants. The three forms required are certificate of compliance, statement of inspection, which is signed by the commission agent performing this service, and an application for a certificate of compliance.

At the same time, the commission revised its gasoline plant reports, and four forms are required. Part of these are new, and part are combinations of forms used previously.

Alcohols from Petroleum Gases

Even if ethyl alcohol finally becomes one of the sources of butadiene, the petroleum industry stands ready to contribute through that route. A part of the history of this development has been given recently by Universal Oil Products Company, as follows:

"Today, when ethyl alcohol is proposed as a source of butadiene, needed in vast quantities for the production of synthetic rubber, it is interesting to note that Dr. Vladimir N. Ipatieff, director of chemical research, Universal Oil Products Company, and a professor of chemistry at Northwestern University, was the first to establish formation of butadiene from ethyl alcohol in a single-stage operation.

"However, Professor Ipatieff carried this work, which was done in Russia in 1903, only as far as the laboratory stage, being interested primarily in other objectives at the time.

"Later workers have made further important discoveries in this field and have developed efficient processes to produce this vital chemical in huge volume economically from alcohol. These processes are now being offered to American refiners.

"Acknowledgment of Ipatieff's early achievement is made by Dr. S. V. Lebedev in his article, 'Preparation of Butadiene Directly from Alcohol,' published in 1933.

"Lebedev was one of the greatest of Russian chemists and is conceded to have played the largest part in developing commercial rubber from alcohol for his country. He was decorated by the Soviet government for his achievements.

"Dr. Lebedev's work has been translated as a part of the current issue of Universal Oil Products Company Survey of Foreign Petroleum Literature, by J. G. Tolpin.

"The U.O.P. Survey is now engaged in translating completely the Russian literature covering the extraction of butadiene from petroleum gases, as well as its production from alcohol.

"It is pointed out by leading chemists that petroleum gases are an economical source of ethyl alcohol."

Egloff Heads American Institute of Chemists

Dr. Gustav Egloff, director of research of Universal Oil Products Company, Chicago, was elected president of the American Institute of Chemists at its annual meeting in Atlantic City, May 16. He was recipient of its gold medal in 1940, an annual award presented to the man adjudged to have made significant contributions to chemistry and to the welfare of the chemical industry during his career.

Other officials are Donald A. Price, National Oil Products Company, Harrison, New Jersey, vice president; H. S. Neiman, New York, secretary.

A chapter of the institute in Chicago is now being organized by Dr. Egloff.

E. J. Barth Now with National Oil Products

E. J. Barth, petroleum technologist, has joined the research and development staff of National Oil Products Company, Harrison, New Jersey.

THE LOOK BOX

Plant Protection Provided by OPC

W. D. Mason, who has been manager of refining operations for Sun Oil Company at Marcus Hook, Pennsylvania, has been named head of the Facility Security Division of the Office of the Petroleum Coordinator. Activities of the division will be integrated with the facility security program of the Office of Civilian Defense.

In making announcement of the division, Ralph K. Davies, deputy petroleum coordinator, said the assignment would consist of directing security work relating to all petroleum facilities, developing plans and procedures that will insure protection of vital petroleum products, representing OPC in all matters relating to facility protection, advising and consulting with other agencies of the government as well as the industry in matters of plant protection.

President of Union Joins War Board

Reese H. Taylor, president of Union Oil Company, Los Angeles, has been named chief of the division of iron and steel of the War Production Board. Previous to his connection with Union Oil Company in 1938 he was vice president of Consolidated Steel Corporation.

Since he will not resign as president of the California company, W. L. Stewart, executive vice president, will take over duties formerly directed by the president.

CONVENTIONS

JUNE 8–11	American Society of Mechanical Engineers, Semi-Annual Meeting, Cleveland.
22–26	American Society for Testing Materials, Chalfonte-Haddon Hall, Atlantic City.
SEPT. 7–11	American Chemical Society, Buffalo, New York.
OCT. 5– 9	National Safety Congress and Exposition, Stevens Hotel, Chicago.
12–14	American Society of Mechanical Engineers, Fall Meeting, Rochester, New York.
25–29	National Lubricating Grease Institute, New Orleans.
NOV. 9–13	American Petroleum Institute, Stevens Hotel, Chicago.
16–18	American Institute of Chemical Engineers, Netherlands Plaza, Hotel, Cincinnati.
17–21	National Chemical Exposition and Industrial Conference, American Chemical Society, Stevens Hotel, Chicago.

NGAA Considers Its Place in War Effort

Along with its technical program the Natural Gasoline Association of America devoted part of its annual meeting in Tulsa May 14 and 15 to consideration of the war program on this branch of the petroleum industry. Shortly before the meeting opened the natural-gasoline and natural-gas industries were given a separate division in the Office of the Petroleum Coordinator. This drew favorable comment.

The order from the Office of Petroleum Coordinator by which tank cars were removed for hauling any petroleum product unless the product is to travel more than 100 miles from point of loading also had major consideration. A committee was named to take the matter up with authorities in Washington. C. R. Musgrave, vice president of Phillips Petroleum Company, as chairman outlined the transportation situation within the petroleum industry, with special emphasis on its influence in the transportation of natural gasoline.

Justin Wolfe, attorney for the natural-gasoline and natural-gas division of OPC discussed the workings of priorities with particular reference to Order M-68. Many questions were brought up by the audience.

The Hanlon Award went to E. O. Bennett, chief petroleum engineer of Continental Oil Company. The presentation was made at the annual banquet. William B. Stout, president of Stout Engineering Laboratories, Detroit, was the chief speaker. He gave an optimistic estimate of air transportation, which will be developed during the war and continue during peace.

Committee reports made up the program of the first day when H. L. Oder, Cities Service Oil Company, gave the outline of developments of the gas-testing committee; H. H. Beeson, Sabine Valley Gasoline Company, presented the work of the technical committee; B. R. Carney, Shell Oil Company, gave a paper, "The Density of Liquefied Petroleum Hydrocarbons, Their Mixtures and Three Natural Gasolines"; H. A. Montgomery, Hanlon-Buchanan, Inc., reported on "Studies in Low-Temperature Fractional Analysis of Gases"; and C. H. Gee, La Gloria Corporation, covered the work of the testing of the content of high-pressure wells with "The Testing of High-Pressure Gases."

The strictly technical program was restricted to the morning of the second day. J. W. Wilson, Cities Service Oil Company, presented a paper, "Increasing Recovery of Liquefied Petroleum Gases in Natural Gasoline Plants," and Dr. D. L. Katz, University of Michigan, gave a paper in two parts on "High Pressure Gas Measurement." Both these papers are printed elsewhere in this issue.

Other than a vice president for the newly created High-Pressure Gas Division all officials were reelected. C. R. Williams, The Chicago Corporation, Corpus Christi, was chosen for this position, which was held for a brief time by E. E. DeBack, who died in January. The officials reelected are: Ray E. Miller, Hanlon-Buchanan, Inc., Tulsa, president; H. H. Beeson, Sabine Valley Gasoline Company, Shreveport; H. A. Ells, Cities Service Oil Company, Bartlesville; J. R. Jarvis, Lone Star Gaso-

line Company, Dallas; and J. W. Vaiden, Skelly Oil Company, Tulsa, vice presidents.

The status of the natural-gasoline industry was summed up by D. E. Buchanan, president of Hanlon-Buchanan, Inc., and a member of the staff of the division of natural gasoline in OPC. He recounted the effort of the coordinator to get a picture of what natural gasoline can contribute to the war program through the two reports, which are now being studied. Concerning the outlook he said:

"Only quite recently has any attention whatever been given to the natural toluol content of natural gasoline or condensate from cycling plants. Tests have shown appreciable toluol content in certain natural gasolines, and it is quite possible some of them may prove more desirable for toluol extraction than crude oils currently being processed. There is also the question of methylcyclohexane content for synthesis to toluol, and I urge the earliest possible conclusion of the work I understand your technical committee has undertaken in this direction.

"I regret that I am not, at this time, able to delineate the position the natural-gasoline industry will occupy in the manufacture of synthetic rubber. The synthesis of the butanes to isobutylene and butadiene and of propane to styrene is well known and it seems quite reasonable to suppose that to the extent the manufacture of rubber from the C_3 and C_4 hydrocarbons is superimposed on the requirements for 100-octane gasoline will the demand for those fractions from natural gasoline and cycling plants be felt.

"It is anticipated that alkylation will utilize the butylenes and isobutane currently incorporated in motor fuel to the extent that the resultant motor fuel from alkylation plants will have vapor pressure of the order of 7 pounds Reid. This is, of course, too low and indicates the need for normal butane to bring volatility up to some point of more satisfactory performance but here again it is too early to predict the extent of requirements from your plants. Suffice to say, it is not beyond the possibility that it may be necessary to use propane to some extent for this purpose.

"As to when you may expect this demand to materialize, it can only be said that from present indications the halfway mark of the present 100-octane program should be reached early next year and the goal by December, 1943. The demand for isopentane for 100-octane gasoline is also under investigation. It now looks like the natural-gasoline manufacturer may not fare so well here. Catalytic cracking produces more isopentane than can be used in blending to present 100-octane specifications. It, therefore, appears that those refiners utilizing the catalytic-cracking process may have excess isopentane available for refiners operating other types of processes.

"At best the supplier of only a raw material is in a subordinate role. A parade of vastly improved processes made necessary by, and designed for, the primary production of war products is going by. I see the natural-gasoline industry standing on the sidelines. The war will be over some day. It is reasonable to assume that at that time there will be a surplus of manufacturing capacity for high-octane gasoline. Where will the natural-gasoline industry be if it has taken not one step forward in the parade? It will not only be out of date, it will be archaic. What customer of yours will even be able to use, let alone pay you a decent price for your product if it is points below the level of octane requirements of the going grades of motor fuel?

"You should couple up with your patriotic desire to contribute everything possible to the winning of the war the question of self-preservation during and after the war. This would seem to dictate a thorough appraisal of your present and probable future position in the motor-fuel economy and a study of the feasibility of producing 100-octane gasoline (and don't stop at 100) as well as butadiene and styrene for synthetic rubber, and toluene, all finished products at your plants. Obviously, every natural-gasoline plant is not a prospective 100-octane or butadiene plant. Construction and operating costs must be competitive with present and authorized operations but there are plants and combinations of plants with sufficient volume of raw materials available to make

Bennett Honored for Service by NGAA

E. O. BENNETT, chief petroleum engineer of Continental Oil Company, Ponca City, was recipient of the Hanlon Award as part of the program of the annual meeting of the Natural Gasoline Association of America, Tulsa, May 14 and 15. The honor goes each year to a man whose scientific contributions to the natural-gasoline industry are considered the most outstanding. The decision is by committee selection and the award is by E. I. Hanlon of the Hanlon companies, Tulsa. In addition to having his name engraved on the scroll the recipient is given a gold watch.

Bennett has contributed examples of combining natural-gasoline-plant operation along with reservoir-pressure maintenance and crude stabilization in oil-field development.

Following graduation from Stanford University in 1917 he went with Standard Oil Company of California as a pipe-line engineer. During World War I he was in charge of the Langley field laboratory of the National Advisory Committee for Aeronautics, after which he returned to the California company and was engaged in design and construction of natural-gasoline plants. In 1924 he joined the United States Bureau of Mines at Bartlesville station where he was in charge of natural-gas work. Here he developed the back-pressure method of determining the productive characteristics of wells. Later he was placed in charge of oil-recovery work.

From the Bureau of Mines he went to Marland Oil Company where he was chief petroleum engineer and chief engineer. When this company was merged with Continental Oil Company he became assistant manager of production and later was promoted to chief petroleum engineer.

Part of the citation, read by Ray E. Miller, president of the association and a former business associate, was:

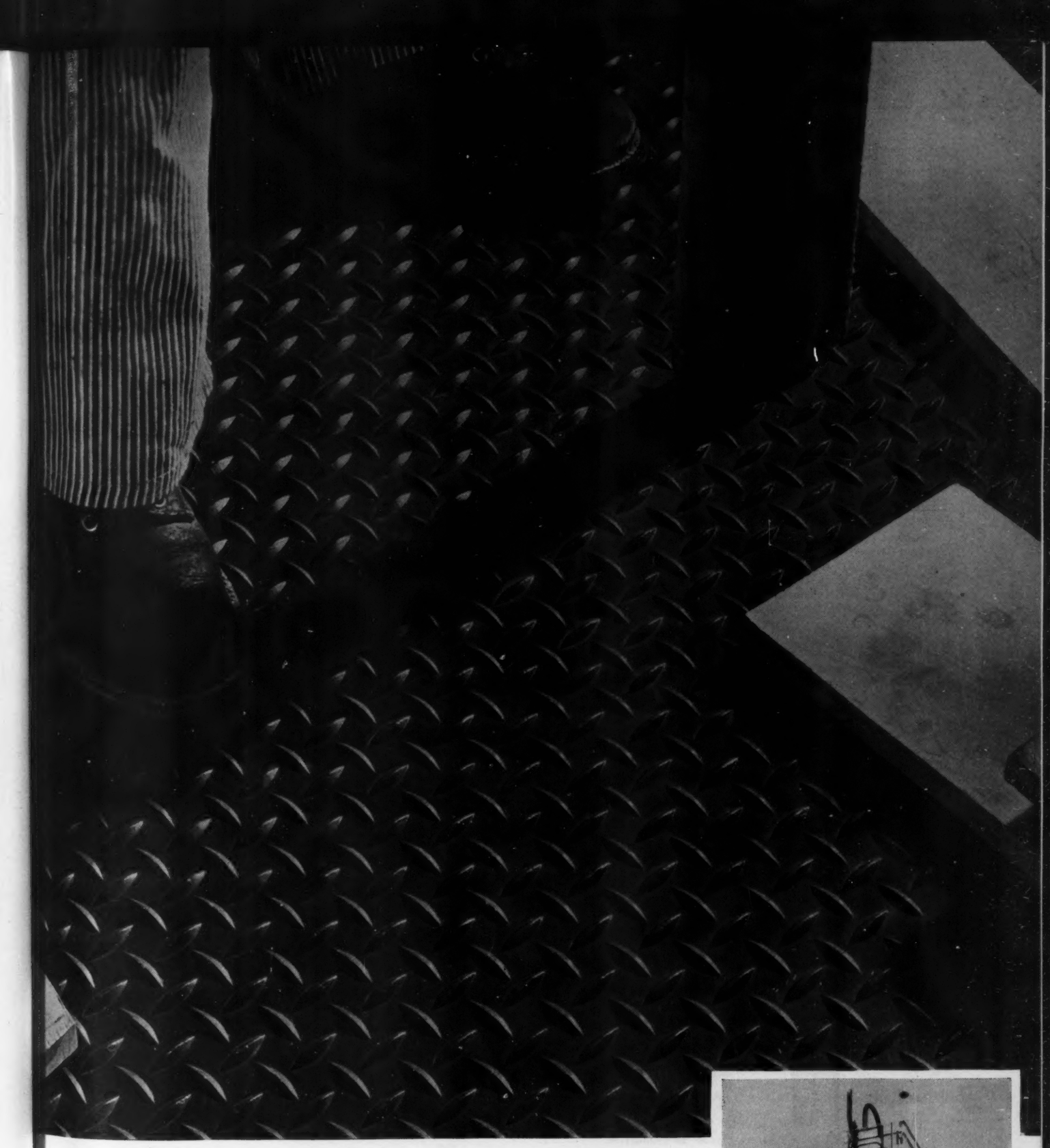
"He is best known to the natural-gasoline industry for his work in high-pressure gas and gasoline operations. It was his guiding mechanical genius which resulted in the design, construction and operation of the high-pressure gasoline plants which his company operates. These plants have pointed the way for modernization of natural-gasoline operations where maximum recovery and conservation of natural resources through repressuring and pressure maintenance are prime considerations. In every case these plants are designed for the purpose of taking from the reservoir the ultimate hydrocarbon content, both oil and gas, while maintaining the reservoir pressure at maximum efficiency. They also represent the coordination of the production, refining and natural-gasoline departments of a single company, a circumstance which is not too often seen but which could be followed with profit by many other companies.

"This work preceded most developments in the new and fast-growing cycling phase of our business and has led to absorption methods under extreme pressures which are now accepted means of condensate recovery.

"With the consciousness that the natural gasoline industry must now look upon its plants as potential producers of raw material for rubber, chemicals and high-octane gasoline rather than producers of a single commodity, we can turn to the proven ideas of this man for many of the practical mechanical means of changing our methods to meet more modern requirements.

"This man has made many significant and valuable contributions to the literature of oil and is the inventor of a number of devices widely used in the oil industry."

E. O. BENNETT



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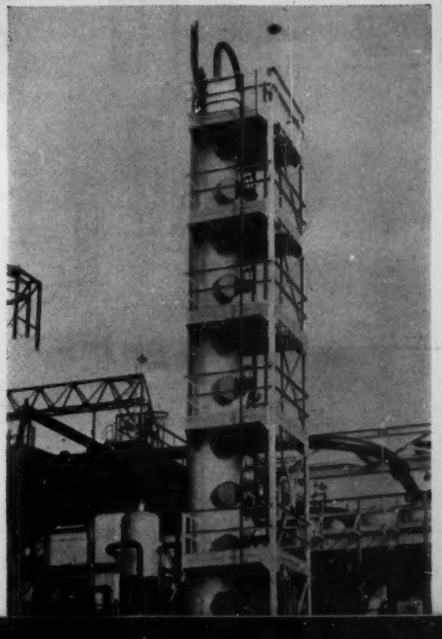

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complete installations well worth considering. In some cases geographical location, in that they are well outside the so-called "target area" and considerable distance from any deep-water coast, will be in their favor.

"I might say right here that the super aviation fuel of the future is being developed from natural-gasoline derivatives—but not by the natural-gasoline industry."

Foxboro Employes Have Anniversary

Employes of The Foxboro Company, Foxboro, Massachusetts, who have completed 25 years or more in its service were guests of the company at a celebration the evening of May 26. A jeweled service pin of gold was presented to each of the 50 men and women thus honored, and a program of entertainment, supplemented by the reminiscences of old-timers, made the occasion an enjoyable one.

Almost another 50 employes have service records which are within a few months of the quarter-century mark; and it is therefore assured that similar celebrations will be held annually, hereafter, to welcome new members as they qualify.

The Foxboro Company was organized in 1908 as the Industrial Instrument Company, but adopted its present name in 1912. The company maintains 28 district offices in the United States and branch factories at Pittsburgh, Dallas and San Francisco, and has complete factories in Montreal and London.

OPC Warns Industry It Must Use Substitutes

The oil industry was warned by OPC June 8 that no priorities will be granted for critical materials for which substitutes can be found.

WPB has declared that the following materials, most of which are used at times by the oil industry, are scarce materials, vitally needed for war purposes and in general are termed critical: aluminum, asbestos, cadmium, calcium-silicon, chromium, cobalt, cork, copper and copper alloys, lead, magnesium, plastics, nickel, rhodium, steel and iron of all types, and their alloys, tin, tin plate and terneplate, tungsten and tungsten carbides, vanadium, zinc and zinc-coated metals, cotton duck, manila fiber and cordage, jute, burlap, kraft paper, lead, manganese, mercury, sisal, and rubber of all types, new and reclaimed.

"Engineers designing plants for which a project application will be made should take into consideration the vital and scarce nature of these materials and in every instance should eliminate their use if it is at all possible to do so, finding substitutes therefor, and where elimination is not possible, reduce the quantity as much as possible," the OPC materials division declared.

Also listed were certain classes of materials and equipment, use of which is not permitted by WPB, as follows:

Galvanized iron and steel pipe, except where the properties of the water demand zinc coating.

Steel water tanks (except closed pressure types).

Both black and galvanized corrugated iron and sheet for side walls and roofs for buildings.

Eighty-five percent magnesia pipe covering for insulation purposes except where temperatures exceed 212°.

Metal-base plumbing fixtures.

The use of cork for insulation except where extremely low temperatures are required.

Valves and fittings which are trimmed with chromium, stainless steel, bronze, brass, or nickel except to meet special processing requirements. Valves over two inches with brass bodies are usually prohibited.

Steel sash, windows and frames, steel bunks, steel doors and frames, steel roof decking, metal roofing, except where extreme fire hazards exist.

New steel storage tanks to be used for fuel oil, crude and other heavy oils whenever it is practicable to construct concrete storage tanks.

Cast iron soil pipe, or sewage pipe except those of standard weight and then only those portions required within a building.

Ferrous metal for water mains where the use of asbestos cement, concrete or wood pipe is practicable.

Water-well screens made of brass, copper and other non-ferrous alloys. Gravel-packed screens or screens of other types will serve the purpose for a reasonable length of time.

Steel wire fence of the chain link type.

Ferrous metal culverts.

Electrical conduit (metal) where wiring can be safely installed without it.

Stand-by equipment. Spare parts to be held to a bare minimum.

Priority Applications

In a statement designed to clarify the situation, the material division of the coordinator's office cautioned that applications for priority ratings will be expedited more promptly if they are made out in accordance with WPB rulings and if the required forms are properly filled out.

"Construction equipment of all kinds and oil-well-drilling equipment must not be included in a project application since such equipment does not become a permanent part of the finished project," it was explained.

"Machine tools, rubber products, chemicals, business machines, office furniture, office supplies, automobiles, trucks and tires should not be included in project applications; there are special orders governing the rating or distribution of these materials.

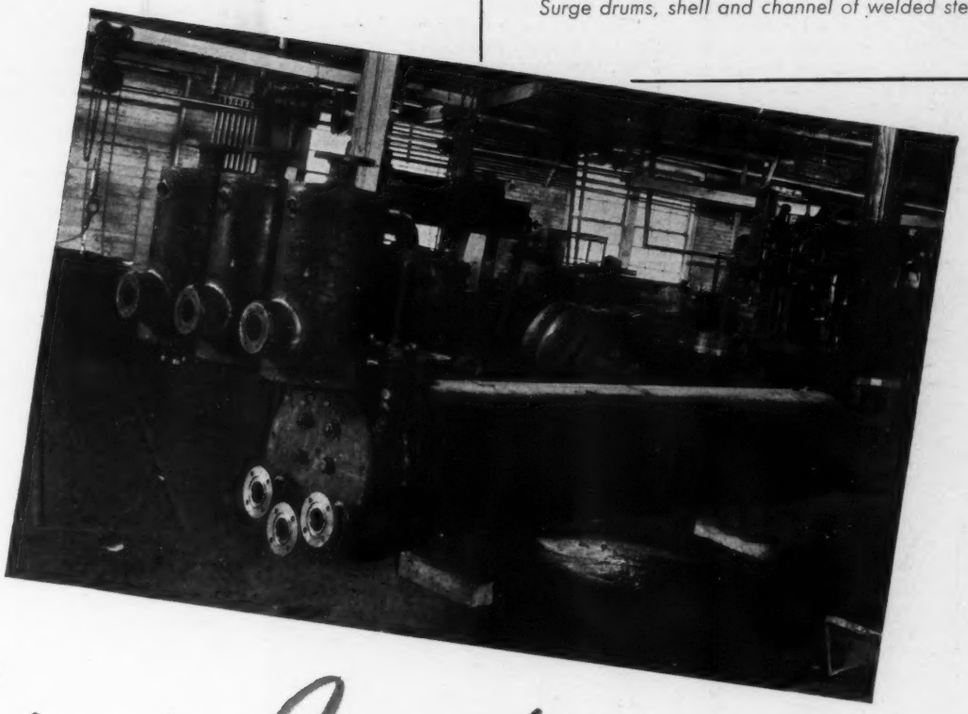
"Aluminum and steel plate are on allocation and are being allocated only to those projects which are extremely important in the war program. Projects should be designed so far as possible to minimize or eliminate their use. Every effort should be made to keep steel plates under 3/16-inch, where steel plates must be used.

"The most critical materials are aluminum, stainless steel, chromium steel, nickel, tin and copper. It is probable that items of material requiring these alloys will be denied by the War Production Board unless accompanying information is provided with the project application explaining why these alloys must be used, why no substitute can be used, and a further statement to the effect that the percentage of critical metals in the alloys has been reduced to a practical working minimum.

"The petroleum industry's refining

AS EASY TO SEE AS THE SUNSET PALMER
"Red-Reading-Mercury"
THERMOMETERS
"Easy to See" means time saved to help speed up production.
It eliminates incorrect reading and saves waste through errors.
PALMER Thermometers, in addition to the brilliant RED column, are also strongly built for long wear, which is important today.
SPECIFY PALMER . . . ON YOUR NEXT ORDER!
(CATALOG No. 300-D SENT PROMPTLY)
See page 422 in Refinery Catalog.
red reading mercury
THE PALMER CO., Mfrs.
Industrial, Laboratory, Dial and Recording Thermometers
2513 Norwood Ave., Cincinnati, (Norwood) Ohio
Canadian Plant: King & George Sts., Toronto
See telephone directory for Palmer representative.

775' of ¾" No. 16 B. W. G. tubing went into this Patterson-Kelley Recirculating Gasoline Cooler. A single shell houses 3 separate circuits. It is furnished with individual surge drums. Shell baffles are of copper. Surge drums, shell and channel of welded steel.



Engineering Ingenuity BY PATTERSON-KELLEY

From the point of view of size and materials required for its construction, this Patterson-Kelley recirculating gasoline cooler isn't what industrial engineers would call a "big" job. But the unique arrangement of its individual surge drums proved to be the *right* answer to the operating conditions it was designed to meet.

You'll like the way Patterson-Kelley engineers approach a problem in the design or construction of a piece of refinery equipment. In the first place, their attitude is that *there is a right answer* to any legitimate problem in engineering—no matter how difficult it may be. In the second place, they give the same careful attention-to-details to a small cooler or condenser that they do to a large interchanger which may require 7,500 square feet of heating surface.

At Patterson-Kelley's East Stroudsburg plant there is no compromise of quality in materials or in workmanship. We are prepared to design and build equipment to meet the most exacting requirements of your operations. Our engineers will be glad to consult with you on your equipment problems—at no cost to you.

PATTERSON-KELLEY *FOR DEPENDABLE ECONOMICAL SERVICE*

EST. 1880

PATTERSON-KELLEY HEAT EXCHANGE ENGINEERS

THE *Patterson-Kelley* CO., INC.

113 WARREN ST., EAST STROUDSBURG, PA.

MANUFACTURERS FOR THE REFINING AND PROCESS INDUSTRIES

projects require a great deal of chromium steel," it was stated. "The War Production Board is insisting that projects be designed with the least amount of chromium or other alloy metals possible. The War Production Board suggests that where scarce alloys are necessary, we plan on frequent replacements if, by so doing, we are able to reduce the amount of such scarce materials, unless such replacements would cause extraordinary expense, such as tearing down boiler settings, etc. Frequently 1½-percent-chromium steel will give two years service, in equipment which is usually designed with 4-to-6-percent chromium. Every pound of chromium steel which the petroleum industry uses must be taken from a ship or a shell, and consequently, every pound of chromium steel is precious. All steel plate is being allocated and only those projects which are the most important in the war program are receiving it. The ship-building program is behind schedule because of the shortage of steel plate; therefore, projects should be so designed as to minimize to the greatest extent possible the use of steel plates and sheets.

"Steel storage tanks require plate for the large sizes and sheet for the small sizes. Before requesting new tankage, every effort should be made to find available second-hand tanks which can be cut down, moved, and re-erected at the desired location.

"All large compressors are now on strict allocation and are not available except for the most vital projects. Wherever compressors, pumps, electric generators or motors are required, every effort should be made to find second-hand equipment which will do the work. They are all scarce and critical.

"Where tubular goods are required use second-hand materials whenever possible. Salvage unused lines and if possible lines which are not operating to capacity. Whenever new pipe is required, a size should be chosen only sufficiently large to carry the amount of fluid which must be handled, and the weight of the pipe should be consistent with the pressure under which it must operate. Use the smallest and lightest pipe possible. Do not allow for greater capacity or greater pressure which might be required at some later date. Seamless pipe and tubing are not available except where required in processing equipment subject to high temperatures and high pressures. When possible, specify welded pipe in your application.

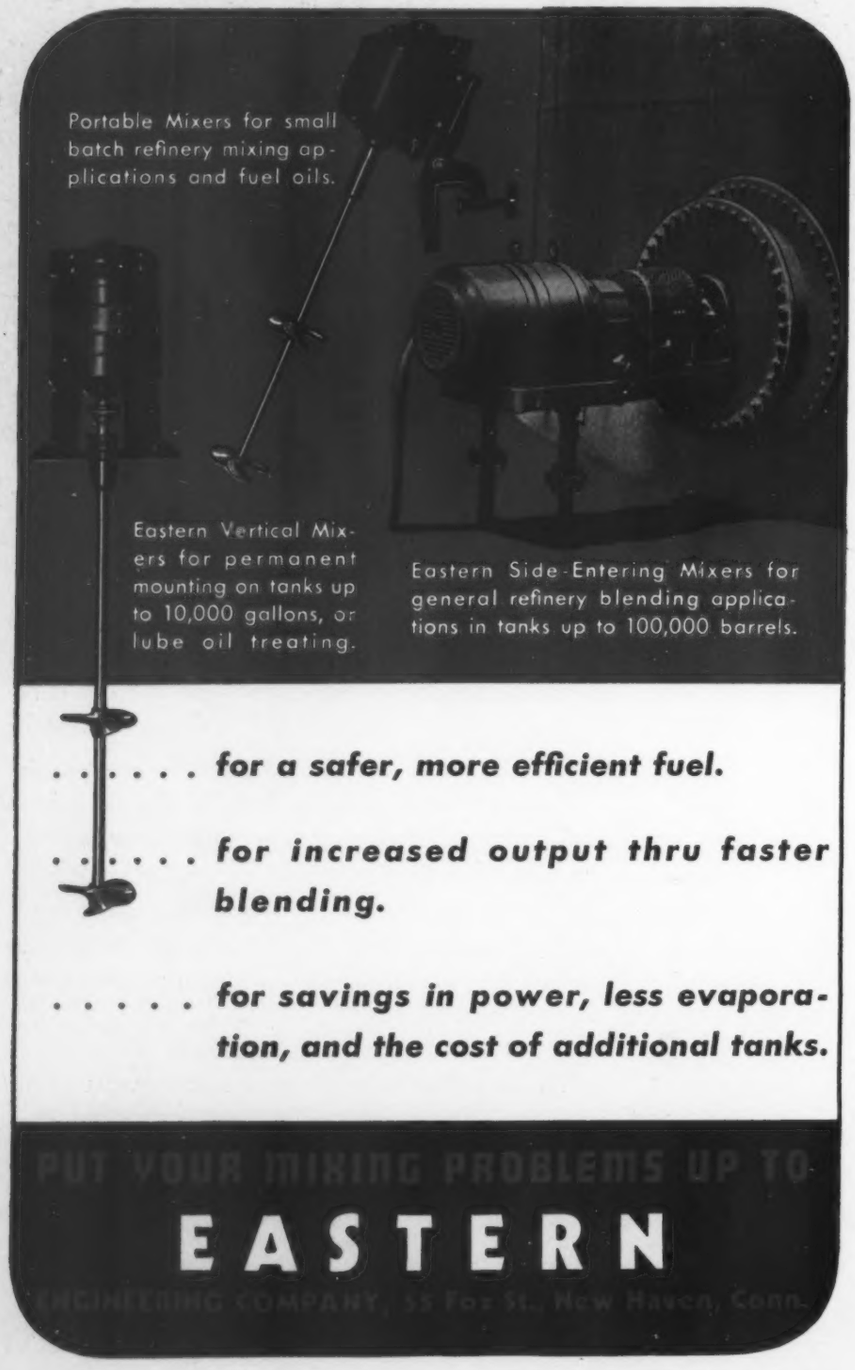
Buildings Without Steel

"Buildings and other structures should be designed to use as little structural or other steel as practicable. Structural steel may be used only when it is necessary to support or carry heavy equipment, craneways, etc. Loading racks should be designed with wooden structures and walk-ways. Bear in mind that the use of steel alone is not fireproof construction.

"It is the practice of the War Production Board to assign preference ratings sufficiently high to insure the procurement of materials only when it can be shown that the materials are to be used in a project necessary in the prosecution of the war. In very few instances is the War Production Board authorizing an increase in rating simply because material cannot be procured on the rating which has been assigned.

"In making an application for a preference rating for a project as prescribed on Form PD-200 and PD200a, the instructions should be followed implicitly and completely and each item of material and the value thereof listed in accordance with the form. When a number of items are lumped together with one value and it becomes necessary to deny or delete certain items, it is then necessary to write to the applicant for the prices of the items denied so that the value of all rated materials may be shown correctly. This delay can be avoided if the applicant adheres strictly to Form PD-200 and PD-200a.

"In the designing of projects for which a preference rating is to be applied, engineers should become reconciled to the fact that we are engaged in an all-out war requiring scarce materials far in excess of our available supply. Many engineers are designing for long life and with high factors of safety just as they designed before we entered the war, when these scarce materials were abundant. Every feature of design should be studied with the thought in mind of reducing or eliminating the amount of scarce materials to the greatest extent possible. We must become reconciled to a less permanent type of structure even though we may have to replace parts of it at frequent intervals. The War Production Board recognizes that temporary or cheap construction and the absence of stand-by facilities creates certain hazards, but it believes that industry must assume its share of the hazards along with the Army and the Navy."


Portable Mixers for small batch refinery mixing applications and fuel oils.
Eastern Vertical Mixers for permanent mounting on tanks up to 10,000 gallons, or lube oil treating.
Eastern Side-Entering Mixers for general refinery blending applications in tanks up to 100,000 barrels.
. . . . . for a safer, more efficient fuel.
. . . . . for increased output thru faster blending.
. . . . . for savings in power, less evaporation, and the cost of additional tanks.
PUT YOUR MIXING PROBLEMS UP TO
EASTERN
ENGINEERING COMPANY, 55 Fox St., New Haven, Conn.

Rationing Dominates Washington Affairs

Rationing of gasoline and transportation to the East Coast became political as well as economic issues in Washington during May and early June. Indications that use of gasoline might be restricted for the nation subsided, while the transportation problem was thrown back to its original status with refusal of the House of Representatives to approve a combination of pipe line and canal facilities across Florida.

Possibilities that WPB was seeking a graceful way of reversing its position on the East Coast pipe line also were seen in the disclosure that a committee of engineers would be appointed to study the application filed by Coordinator Ickes.

Both national-rationing and pipe-line policies are expected to be laid out in the White House, where President Roosevelt has been appraised of the increasing public demand that the Administration "do something" about the situation.

Linked inextricably to rationing is the question of rubber, another sore point with the public, which appears something less than satisfied with explanations that gasoline restrictions will conserve rubber. With no assurance that with even the maximum of conservation, the war would be ended before today's tires are worn out, the major question is what good it will do to make those tires last a few months longer if no new ones will be available when finally they do blow out for the last time.

But the Truman Committee investigating the defense program could find no hope that civilians would get rubber within the next three years. In a 57-page report the committee rehashed the Standard-I. G. agreement in 1929, criticized the Army and Navy for not attempting to conserve rubber and slapped at Secretary of Commerce-RFC Chairman Jesse H. Jones for dilatory handling of the rubber program, but held that butadiene was the bottleneck of synthetic production.

Rationing

Controversy over nation-wide gasoline rationing continued unabated during the week, with members of Congress from the producing states particularly vocal over the possibility that car owners in producing fields would be required to observe the same restrictions as those in the East Coast area.

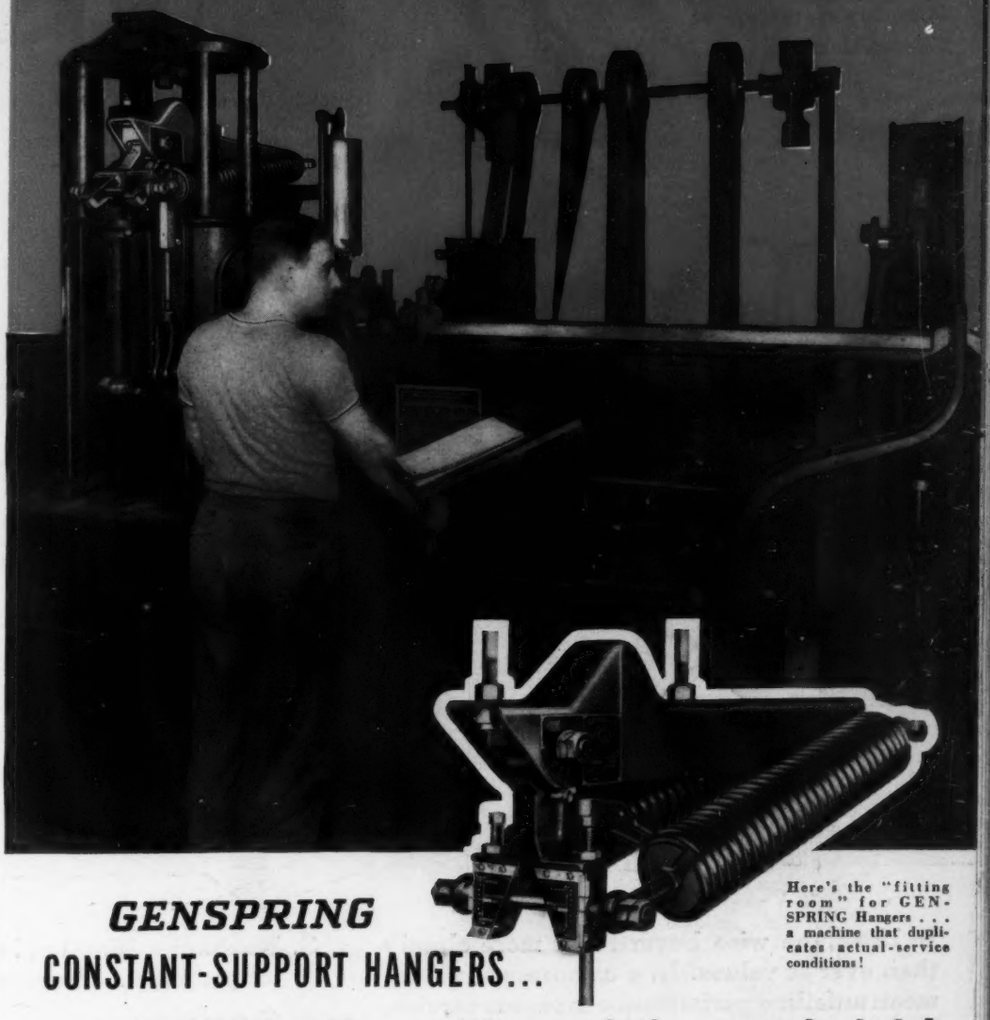
All pretense that such rationing would be due to disruption of transportation was dropped during the week, and officials admitted that the only excuse for general control of gasoline consumption would be the desire for conservation of rubber.

With that in mind, Senator Lee of Oklahoma telegraphed President Roosevelt and WPB Director Nelson, urging that a conference of the governors of oil producing states and industry representatives be called before any general rationing order is issued.

Such a conference, he said, would permit the situation to be fully explained to the public before any action is taken and then, he added, "if gasoline rationing will contribute rubber to the war effort and a reasonable explanation is given to our people, they themselves will enforce it."

With the Truman Committee report for a springboard, the Senate got into

PRE-FITTED to Your Installation!



Here's the "fitting room" for GENSPRING Hangers . . . a machine that duplicates actual-service conditions!

GENSPRING CONSTANT-SUPPORT HANGERS...

are individually calibrated for each job!

There's no chance of misfits in the hangers for your power piping . . . no delays for "fussy" calibrations, . . . when you specify GENSPRING Constant-Support Hangers!

Every GENSPRING unit is *pre-fitted* before shipment . . . tested and calibrated under load-and-travel conditions that duplicate actual-service specifications. Yet, field changes up to ±16% of rated hanger load may be made after installation with the simple adjustment built into each hanger.

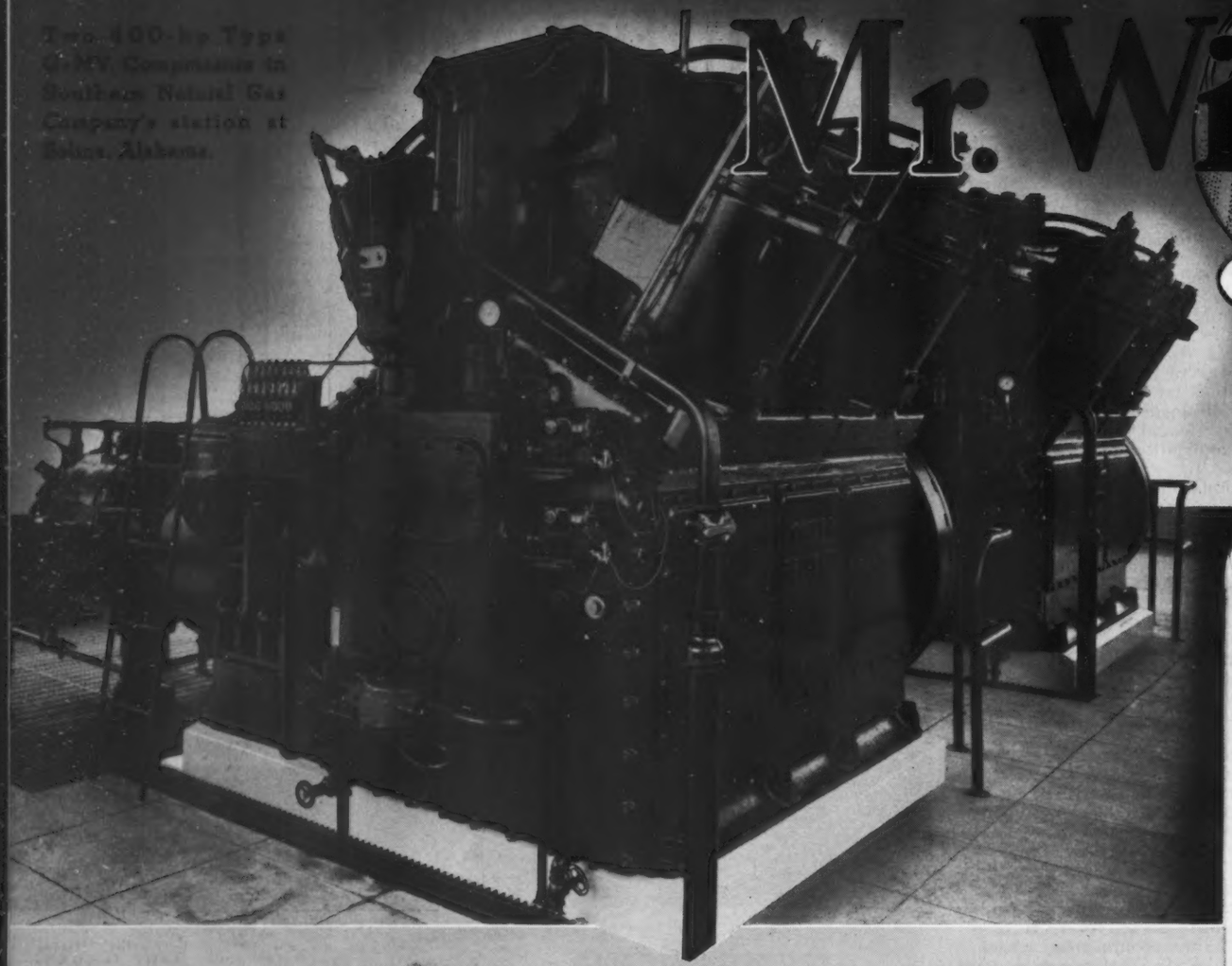
These are only two of the advantages of "floating" pipe-suspension by GENSPRING Hangers. Through unique engineering design, these hangers provide constant support for piping in every "hot" and "cold" position. The weight of pipe is always balanced . . . transfer of vertical vibration to the pipe is eliminated . . . the safety factor of the complete system is effectively maintained. And *all* in minimum headroom!

WRITE FOR complete Data Book on GENSPRING Hangers containing piping-travel calculations.

Get full details of GENSPRING Constant-Support Hangers for loads from 250 to 8500 pounds. Costs are moderate due to mass production and interchangeable parts. Grinnell Co., Inc., Executive Offices, Providence, Rhode Island. Branch offices in principal cities of United States and Canada.

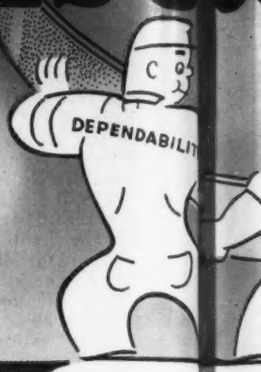
GENSPRING CONSTANT-SUPPORT HANGERS BY GRINNELL

WHENEVER PIPING IS INVOLVED



Two 400-hp Type G-MV Compressors in Southern Natural Gas Company's station at Selma, Alabama.

Mr. Wiset



TY

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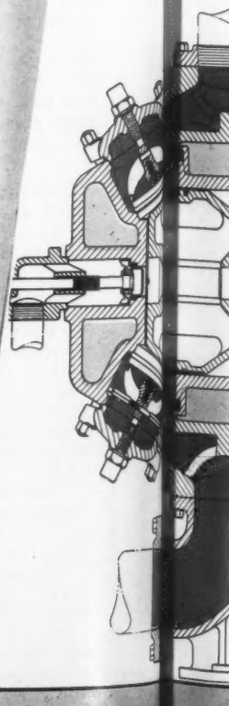
In 1942, the wise buyer looks more closely than ever at values. In a compressor, values mean unfailing performance in severe service, even under heavy overloads, with minimum attention — 24 hours a day for years on end.

Type G-MV marks America's most forward step in direct-driven compressors—a triumph in good design and fine workmanship, backed by the experience gained in 109 years of machinery building.

To the man who lives with compressor problems, the values of these advantages are immediately apparent:

1. V-design . . . more power in less space . . . a shorter, stronger crankshaft . . . fewer bearings.
2. Low-pressure Streamlined Scavenging and controlled fuel injection . . . better combustion . . . more power . . . economy . . . efficiency.
3. Meehanite Metal . . . great strength . . . longer life . . . lower maintenance costs.
4. Open frame design . . . main bearings, and even the crankshaft, quickly and easily removed.
5. Precision-type main and crankpin bearings . . . no fitting and scraping . . . oversize piston-pin bearings.
6. Oil-cooled pistons . . . full force-feed lubrication . . . full flow and bleeder type filtration.

Check these and many other Type G-MV features against your idea of what a compressor should have. Add to all of them the fact that Type G-MV is available in 400, 600, 800 and 1,000-hp units, with a full range of compressor cylinder types and sizes. We believe you will agree that here is the world's most flexible compressor.

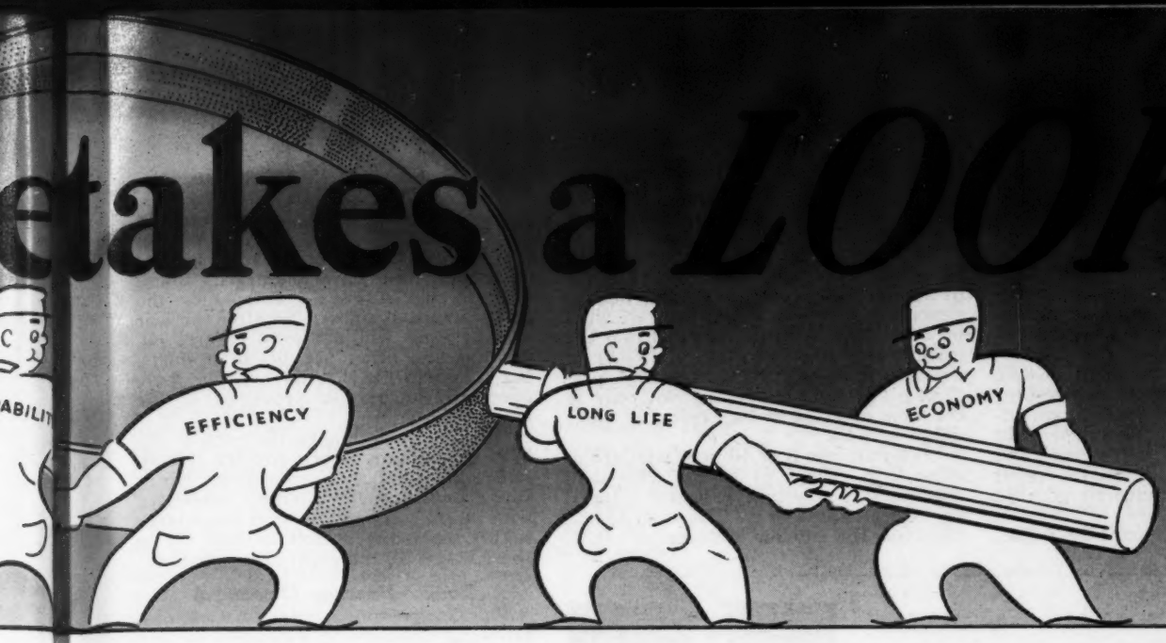


THE COOPER-BESSEMER CORPORATION, Mount Vernon, Ohio

Cooper-Bessemer

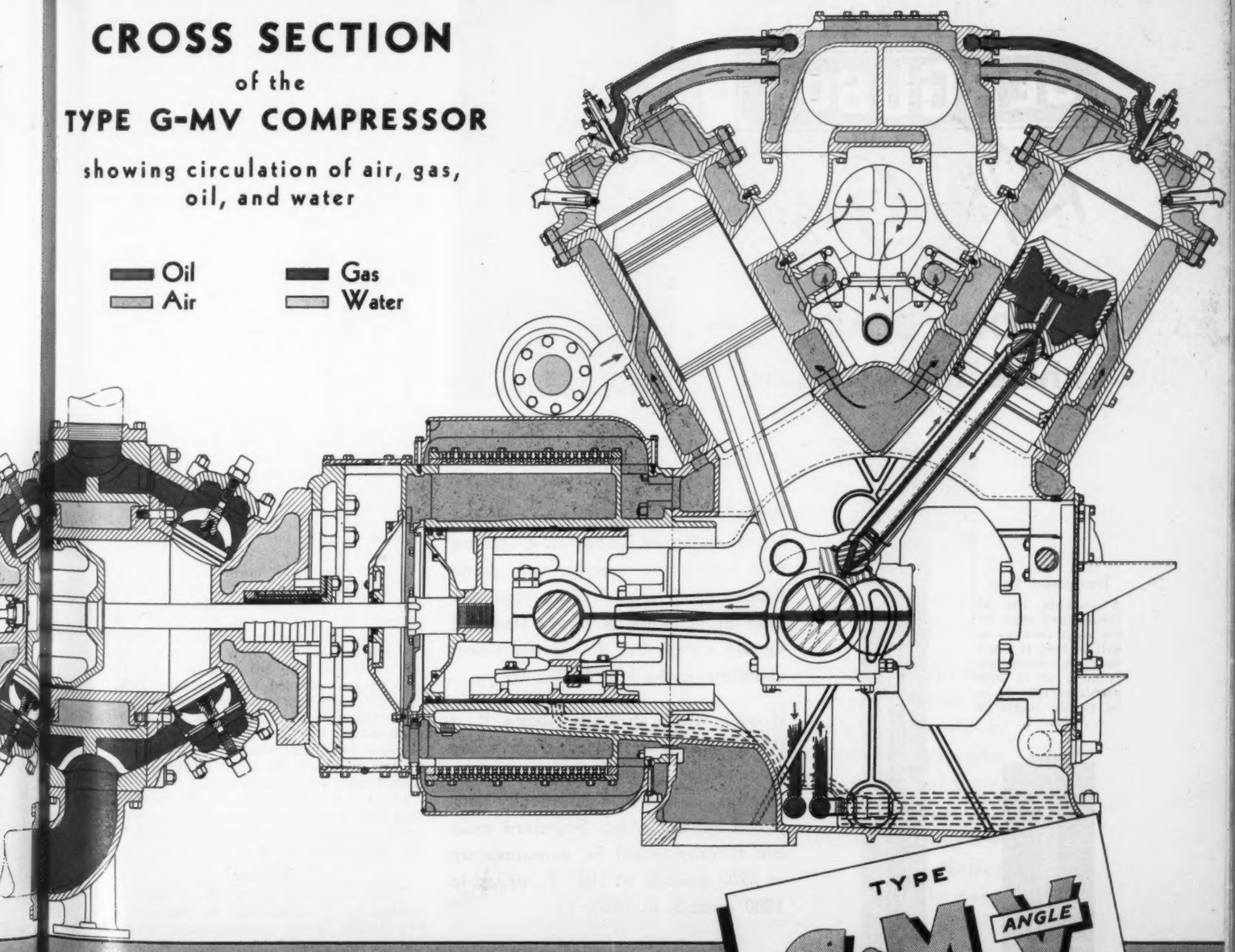
En

...takes a LOOK!



CROSS SECTION
of the
TYPE G-MV COMPRESSOR
showing circulation of air, gas, oil, and water

Oil
Air
Gas
Water



TYPE
G·M V ANGLE
COMPRESSOR

Engine Builders since 1833

a lengthy debate on gasoline rationing which, under the skillful steering of Senators O'Mahoney of Wyoming and Wheeler of Montana, eventually wound up in a discussion of monopoly in the oil industry.

Senator Hatch of New Mexico started the talk by telling the Senate that rationing in his state "didn't make sense," declared that "by curtailing the production, by the pipe lines refusing to take even the small amount of allowable production, the big oil companies are already forcing certain of the independent operators who pledged their money and their credit to the banks, to the point where they will soon have to go into bankruptcy.

"Then what will happen?" he asked. "Who steps in and takes over the independent when he goes broke? It is the majors, the large companies, that get it every time.

"When the major oil companies have succeeded in obtaining complete control of all our resources of oil, and the independent has been driven out, we shall be confronted with the demand that the government step in to take the place of the big monopoly," O'Mahoney predicted. "That is happening not only in the case of oil, it is happening in other fields as well.

"Who are the 8 or 10 men who are at present in charge of saying who shall manufacture rubber?" Wheeler chipped in. "Check them over. The man at the head of the rubber division of RFC comes from the Mellon Institute. The Mellon Institute is dominated by Mr. Mellon's group, which is interested in oil. The Carbon and Carbide Company uses the oil process for the manufacture of rubber. The government is turning over to the large oil companies the manufacture of rubber. So after the war is over they will not only control oil, gasoline and other petroleum products, but they will likewise have a monopoly upon all the rubber produced in the United States.

"Go down the line of the men in the War Production Board and the Reconstruction Finance Corporation. Every single one of them is either connected with an oil company or with some large rubber company which is tied up in some way with the great oil companies."

Public Hearing Demanded

The Congressional attack on national rationing climaxed in a demand of nine Senators headed by Senator Connally of Texas for a public hearing before action is taken.

The group proposed that the hearing be held before Donald Nelson, director of WPB; Leon Henderson, head of OPA, and Coordinator Ickes, and that the governors of the producing states, oil company representatives and citizens generally be given an opportunity to testify.

Participating in the move to force a showdown were Senators Thomas of Oklahoma, Johnson of California, O'Daniel of Texas, Ellender of Louisiana, Chavez and Hatch of New Mexico, Spencer of Arkansas and Doxey of Mississippi.

Big Pipe Line

Asking for high priority on 340,000 tons of steel, a new application for the pipe line from Texas to the Atlantic seaboard was submitted to WPB by OPC May 26

No immediate action was expected on the request, it was indicated by Ickes two days later, because WPB plans to appoint a subcommittee of engineers to make a thorough study of the situation.

Before any decision is made, however, the coordinator hopes to be given an opportunity to argue his case before the board and, he assured a press conference, he will make a vigorous fight for the project.

Ickes expressed confidence that, if the application is granted, no difficulty will be encountered in financing the project. He pointed out that last year the companies were prepared to pay for the line and said if they now could not do so there was no reason why the government should not build it. What disposition might be made of the line after the war, he said, was something with which he was not concerned now.

Ickes estimated that it would require a year to build the line. That, he said, would be two months more than was estimated last year, due to the fact that pipe-line contractors are busy now on other projects, chiefly the digging up and relaying of pipe.

Rubber

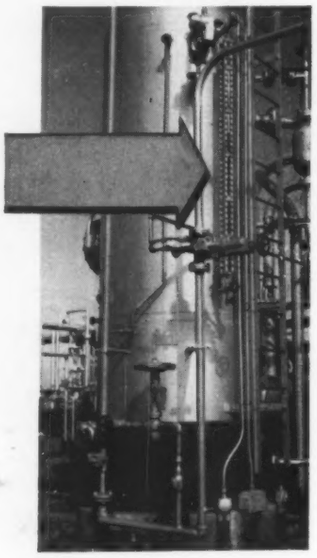
With supplies of crude rubber expected to be exhausted by May, 1943, the special Senate committee investigating the national defense program called on the Army May 26 to adopt a strict conservation program so as to make the greatest possible use of such natural rubber as still remains available.

In a 57-page report, the committee warned that there will be less synthetic

JERGUSON

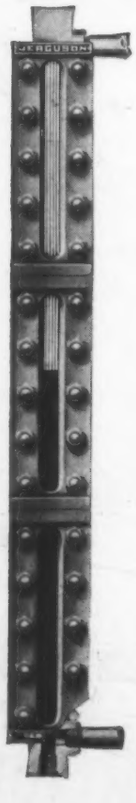
Reflex Gages

SOLID BLACK where there's liquid



Transparent Gage

A complete line of "thru-vision" gages for use where condition as well as level of liquid must be determined. Pressures up to 2000 pounds at 100° F., or up to 600 pounds at 1000° F.



Reflex gage, side hook-up type.

When the above picture of the Jerguson Reflex Gages on a column was taken, the camera was some distance off. It's obvious that the limit of visibility is many feet still further away. So, if you want real visibility, make it a Reflex Gage.

If you want strength, make it a JERGUSON with its forged and alloy steel parts . . . its strong U-Bolt assembly . . . and its scientifically tempered special glass. Standard units are recommended for pressures up to 3200 pounds at 100° F., or up to 1200 pounds at 1000° F.

Jerguson Gage & Valve Co.
87 Fellsway Somerville, Mass.

rubber produced in this country than has been optimistically promised from time to time by officials, and unless Army and Navy requirements are pared to the bone the military forces "may find themselves without rubber at some future date."

No hope whatever was held out for civilian supplies of either crude or synthetic for at least three years; national gasoline rationing and the requisitioning of tires must be given serious consideration, and there is little chance that either Brazilian rubber or guayule will be producible in any amount sufficient to change the broad outline of the picture.

The greater part of the committee's report was devoted to the story of synthetic rubber, and Standard Oil Company of New Jersey was alternately blamed and defended for its policies and actions.

"There is considerable evidence that the development of buna-s type rubber, which is regarded as the best type of synthetic rubber in the United States, was seriously retarded as a result of the 1929 agreement between I. G. Farben and Standard and the action taken pursuant thereto," it was declared.

But, the committee added, "there is no question of moral turpitude or of subjective unpatriotic motive on the part of Standard, or of any of its officials. On the other hand the relationship created by the agreement between Standard and I. G. Farben created a situation where Standard had to choose between fulfilling its obligation to I. G. Farben and what it might otherwise have regarded as its patriotic duty as an American business. As a result, Standard was repeatedly forced into situations which, taken individually and outside of the general pattern of this arrangement, can be construed only as most compromising."

Patents

The report emphasized, however, that a big business views patents not only as an offensive weapon by which to better its own commercial position but also as a defensive weapon to resist the efforts of other companies to better their relative position in industry and "unless a company in the position of Standard took careful and calculated action to arm itself with the strongest patent structure it could acquire, it would have been apt to find itself either paying an enormous tribute to other companies or being excluded entirely from various fields in which it was legitimately interested."

The committee reviewed the evidence submitted at its hearings to show how the I. G. Farben agreement repeatedly stood in the way of the oil company when problems came up in which all industry or the government were interested.

"Summarizing Standard's activities with reference to buna-s rubber up to Pearl Harbor, it is quite clear that in effect the cartel arrangement with I. G. Farben plus the cartel philosophy which remained even after I. G. Farben stepped out of the picture, seriously impeded developments of buna-s rubber," it reported. "On the other hand, Standard has not been backward in offering plans for large plants for raw materials and rubber to be built under government auspices for it and others. Much of its advice in that respect was sound and should have been followed, with, however, proper safeguards to prevent it from unduly exploiting the need for rubber for its own benefit."

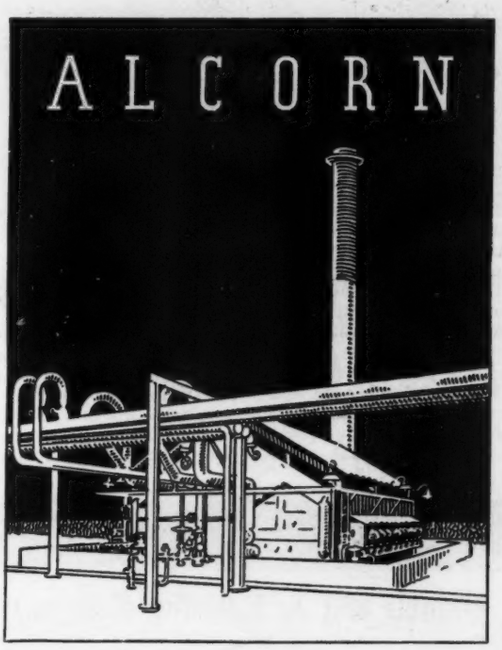
Under the consent decree, it was pointed out, Standard has released its rubber patents, royalty-free for the duration of the war and, it was added, "the committee has the assurance of responsible Standard officials that, despite passages in the 1929 agreements, its understanding with I. G. Farben is now dissolved, and that Standard has no obligation, moral or otherwise, to resume the relationship. It has the further assurance from these officials that it has entered whole-heartedly into the rubber program, and will not withhold its know-how or its information from the government."

Consideration of the production of any form of synthetic rubber, the committee disclosed, develops that the "real bottleneck" is in the raw material field, particularly in the matter of butadiene, and it is in the butadiene field that a government-sponsored program has proven to be most important.

Arnold at It Again

Over the week-end, Assistant Attorney General Thurman Arnold launched a new attack against Standard, filing a 41-page "additional report" charging not only that the agreement with I. G. Farben blocked for years the development of synthetic rubber in this country but also that the company's board of directors was the motivating influence behind an attempt to make an agreement with the Japanese Mitsui firm which, Arnold said, failed only because of the opposition of Shell.

FOR EIGHTEEN YEARS
LEADERS IN OIL FURNACE WORK



CHANGES have been continuous in this field—with the constantly new demands put upon fuels and lubricants. A pioneer in radiant heat, we have seen constant improvement in heat application, have developed many of those improvements. One thing has not changed since the earliest days—heat application, the heart of any process, is most efficient and most economical when it is backed by good engineering and experience.

ALCORN COMBUSTION COMPANY
SCHAFF BLDG., PHILADELPHIA
LOS ANGELES HOUSTON SAN FRANCISCO

Gasoline Plant Study Course Conducted

Forty one workers in the East Texas gasoline plants of Humble Oil & Refining Company were awarded certificates by the company in recognition of the work they have done in conducting a conference course in gasoline-plant operation. The certificates were presented by J. O. Sue of Houston, superintendent of the natural gas and gasoline department of the company, at a barbecue supper at the recreation hall at New London on May 23.

The purpose of the course was to familiarize the men with the smallest detail of operation of modern plant equipment. Participation in the endeavor was strictly voluntary on the part of all concerned, yet every man took advantage of the opportunity to learn more about his plant. Every plant operator received a certificate.

At the request of the men, the course was planned by the plant superintendents under direction of R. E. Buckner, division superintendent at Overton. It was a seminar type course, in which the men on each shift worked together as a group to prepare and present the subject matter for the meetings.

The plants were studied by considering a division at a time; first the gas system, next the oil system, then gasoline, water, steam, and air. An essential part of the preparation for leadership of a meeting was the drawing of a flow sheet of the section of the plant that was being studied. Each group of men made a flow sheet of the various systems of piping in the plants, so that every man would be assured of knowing the location and the purpose of every important and remote line, valve, and regulator in the plant.

The men met in the plant office once a week to discuss the particular section of the plant that had been studied that week. One member of the group that had prepared the lesson for that week would lead the class, and all the men present joined in the discussion. In addition to problems of operation, the men frequently discussed the safest and most practical way of handling hypothetical accidents or blow-outs.

E. B. Woodell, Overton, recipient of one of the certificates, and J. O. Sue, Houston, in charge of natural gasoline plants for Humble Oil & Refining Company.

The service men talked to each plant group about the care and operation of plant machinery and equipment. The electrician gave lectures, with drawings to clarify his talk, on the safe operation of electrical and emergency shut-down equipment. The mechanical supervisor and the repairmen at each plant gave lectures on the correct methods of maintaining and operating vital machinery in the plants. The meter men made sketches of the field lines, showing all block valves and jump-overs on vacuum, residue, and gas-lift lines, and gave a lecture on the operation and significance of the various features of the field system.

The course was carried on for nine months, so that every group of men could have an opportunity to make a drawing of each division of the plant, and lead a discussion on that subject.

That course laid the foundation for another course: industrial defense fire fighting methods, which the men now are studying. The course is contributing to a handbook of information, problems, and working outlines on that subject. This is a unique course, for no information has been published on fire fighting in a gasoline plant. The men are learning to adapt approved methods of other industries to fit the problems peculiar to the gasoline industry.

The following are the names of the men who received certificates; all of them live in the vicinity of Kilgore and Overton:

At the American plant, William H. Baldwin, John R. Carroll, Bernie T. De Ment, James D. Hedgecock, W. L. Lain, Mark Allen Mills, Monroe S. Upchurch, Harry P. Walker, L. Wayne Walker, James V. Ware, and Maurice A. Yowell.

At the Kilgore plant, James Arnold Ates, Oran R. Hawkins, Cecil H. Hilliard, Newton M. Kunkle, Oliver P. Laurence, Thomas R. McEachern, Harry Magness, Curtis K. Mercer, H. Ford Rackley, John E. Rankin, Marion L. Suttle, and Edmond B. Woodell.

At the London plant, Walter B. Burgess, Jessie P. Carroll, C. B. Couch, James M. Diamond, C. Clay Emde, Wayne Foster, Jr., Robert Gentry, William D. Gray, Charles H. Harden, William A. Marsden, Willis R. Mathyer, John M. Simmons, Jr., Felix F. Sparks, Thomas A. Stevens, Edwin C. Tomlin, John Willis, Ira T. Wright, and Wylie B. Wyatt.

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Section B, "Gasoline Tanks," covers in general the same subjects, but with special emphasis on the different hazards, the smaller tanks often involved, and the extra precautions necessary with leaded gasolines.

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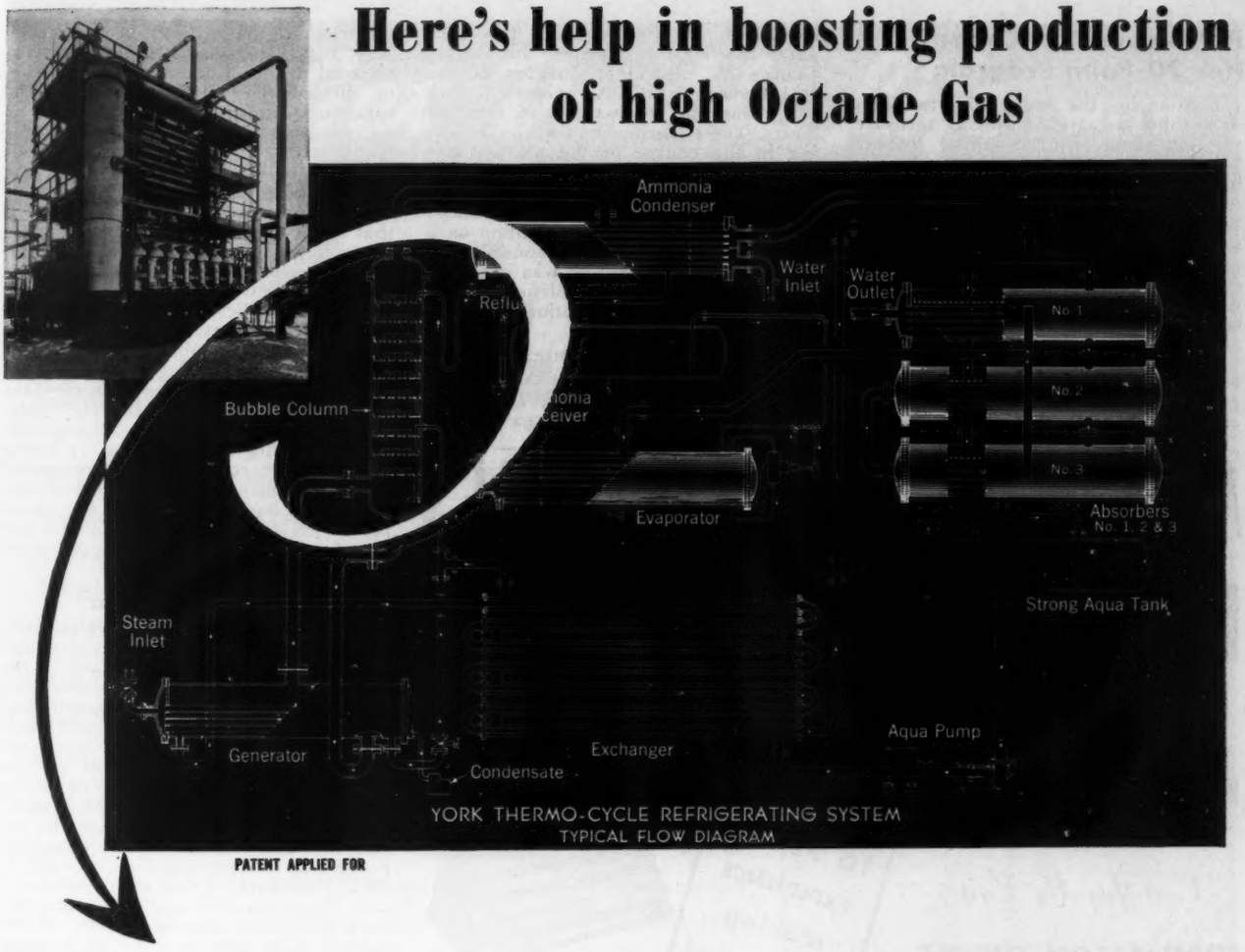

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Petroleum War Council Has 10-Point Program

Denouncing the nation-wide rationing of gasoline as a rubber-saving measure, the Petroleum Industry War Council last week demanded that more adequate information regarding the rubber situation be given the industry and the public before such a step was taken. At the same time, the council, adopting a report of the committee on petroleum economics, called for a further reduction of East Coast consumption until it can be demonstrated that a steady supply of oil in excess of the deliveries which it estimated can be made, can be maintained, and urged the convoy-guarded movement of tankers to increase the flow. Third major subject of discussion at the council's three-day June meeting was prices, on which George W. Stocking, director of the fuel division of OPA, conferred with the group for some two and one-half hours. The situation outlined by Stocking in the course of the session was said to have been "promising," but it was indicated that nothing definite had been offered. In a resolution adopted by PIWC, the rationing of gasoline as a means of securing rubber conservation was strongly opposed, as was rationing on any pretext pending a definite showing that it was needed nationally.

Seek "Adequate Information"

The council's action was taken in the face of information from WPB that a new system for rationing gasoline in the East would be put into effect by July 1 and probably would be made national in scope. The three-day session of the council went deeply into the rationing problem, adopting a resolution opposing nation-wide rationing of motor fuel as a rubber-saving measure now or until the industry and the country are given more adequate information.

"The forecast of essential demand is that estimated as the minimum required for effectively conducting the war effort," the committee explained. "The actual demand will be controlled by available supplies and may exceed or fall short of the estimated essential demand indicated. It will be noted that the anticipated non-tanker receipts can supply the essential demands during the summer, but would be entirely inadequate to take care of the sharply increased winter requirements. If actual demand were reduced to the estimated essential demand, the average shortage of 115,000 barrels daily for the entire period presumably will have to be met by other means, preferably by protected tanker movements.

Needs on East Coast

"This shortage of 115,000 barrels daily is against essential demand only and makes no allowance for demand in the intermediate category of approximately 169,000 barrels daily, which could only be eliminated at severe consumer hardship. It also assumes that East Coast stocks, as of April 1 next year, will be no higher than present depleted levels. Additional deliveries of 63,000 barrels per day would be required over the period to raise these stocks to levels comparable to those existing as of April 1, 1941. Therefore, if real consumer hardship is to be avoided and stocks brought back to a reasonably safe level, 347,000 barrels daily will have to be brought into District 1 by protected tankers or new pipe lines, although the latter could not give relief this year."

Since the estimate of essential requirements of gasoline has practically no seasonal variation, it was pointed out, the winter seasonal increase in the total demand on an essential basis is accounted for entirely by the increased requirement of fuel oil, particularly for heating during the winter. Since transportation will not be released from gasoline, it has been normal during the winter months, a much greater portion of next winter's demand for fuel oil must be met from prior accumulations on the East Coast than heretofore.

"A preliminary analysis of the results of the present card rationing system indicates that the reduced gasoline consumption resulting in District 1 will still be greater by some 70,000 barrels daily than the minimum essential demands estimated," the report commented. "This is partly because the area of rationing does not include important parts of District 1. The essential demands estimated for fuel oils assume substantial reductions in use due to improved efficiency, lower household temperatures, and conversions to coal. To the extent that restrictive measures in consumption of gasoline or conversions of fuel oil installations to coal do not reduce consumption to the estimated essential demands, the shortages against non-tanker supplies will be greater than those indicated."

It was explained that the estimated supplies by non-tanker facilities reported are greater than those previously

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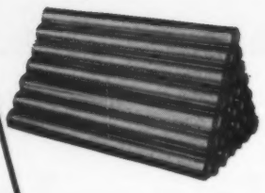

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In addition, certified performance facts from users show that Homestead Boiler Blow-Off Valves give 30% to 60% lower maintenance costs.

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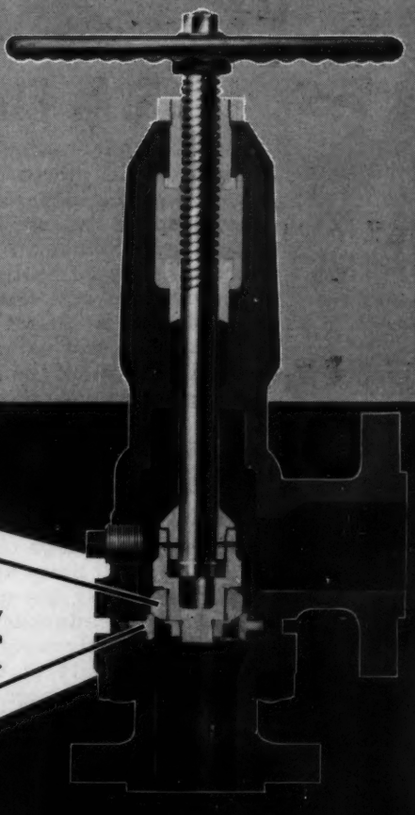
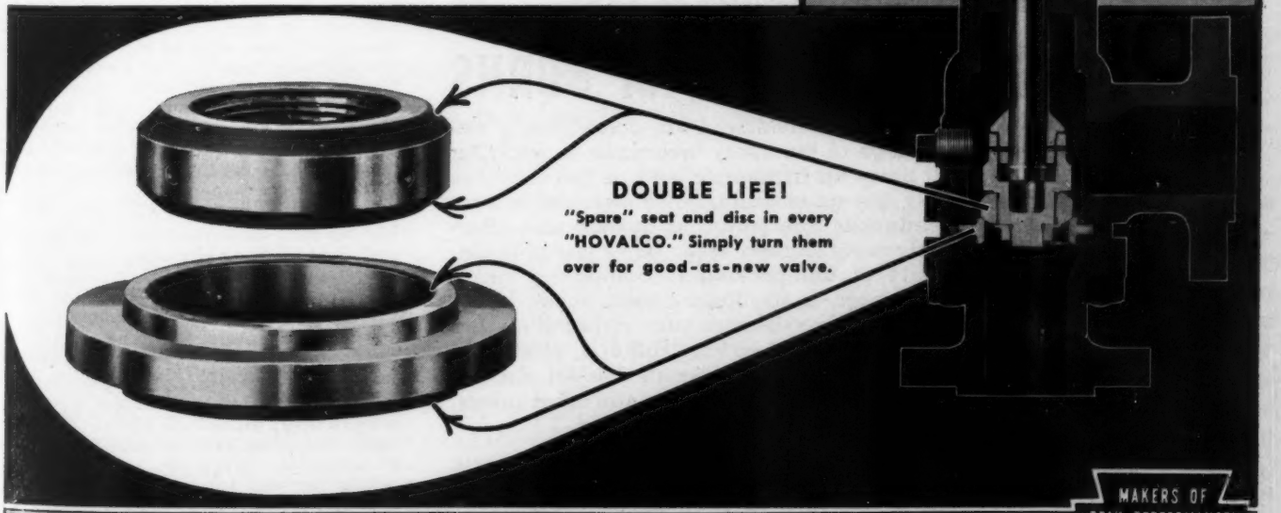
Hovalco Angle Valves, used in combination with (1) Homestead Lever-Seald or (2) Cam-Seald Quarter-Turn Valves, meet the requirements of A. S. M. E. Code and all state laws for boiler blow-off service. Made in 1¼", 2" and 2½" sizes for pressures to 600 pounds.





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forecast, as a result of the receipt of later information from various industry committees. Tank car movements are estimated to increase to 800,000 barrels daily and then decline somewhat during the winter months as a result of reduced transportation efficiency under unfavorable weather conditions. The latest information on barge movement, particularly on the Great Lakes and the Mississippi and Ohio rivers, has had the effect of substantially increasing former estimates. No major pipe lines requiring new steel have been included in the forecast, but consideration has been given to the probable effect of assured projects using second hand pipe.

"During the winter" the committee continued, "inventories on the Atlantic seaboard ususally reach their low point about the end of March, and thereafter rise seasonally. This year a continued decline has occurred up to the present in inventories of total crude and products. Since inventory accumulations during the low consuming period of the spring and summer have not yet begun, it is apparent that this stock trend must be reversed as soon as possible, as the longer such reversal is delayed, the more difficult it will be to attain adequate stock levels.

"The non-essential uses of gasoline on the Atlantic seaboard are proportionately greater than those for fuel oils. Since these non-essential uses have been entirely eliminated in the foregoing forecast, it follows that this area will need more fuel oils in relation to gasoline than it has in the past. These products must be made available from refineries in Districts 1, 2 and 3, approximately in the proportions of essential demand in District 1. This will require refineries in these areas to further change their operations as soon as possible to produce substantially larger quantities of distillates as well as residual fuel oils, and less gasoline, in order that the necessary stocks may be built up this summer. These products should be transported into the East Coast area in these proportions during the entire period, otherwise, the accumulations of heating fuel oils that should take place for next winter's demand will not be accomplished."

Ten-Point Program

In the light of the shortages indicated and the necessity for accumulating stocks during the summer, the committee laid down the following ten-point program:

1. Total consumption in District 1 should be reduced to the approximate daily average essential requirements indicated in the forecast until it can be clearly demonstrated that supplies will exceed that amount consistently.

2. The studies being undertaken looking towards the conversion of all types of burners using fuel oil and kerosene should be concluded at the earliest possible date. Steps should also be taken to assure that these conversions will be made to the extent practicable before the coming winter. Further publicity should be given by both public and industry sources to the necessity for these conversions and the reasons for restricting consumption through economies in order to save petroleum products during this period of transportation shortage.

3. Supplies should be made available so far as possible in the areas nearer to the East Coast so that transportation facilities may be most effectively used. The most obvious sources of such supplies is the western portion of District 1, which should definitely be included in the rationed area. Also, to the extent that supplies of products can be made available in the northeastern part of District 2, tank cars would have about double their capacity for delivery into District 1 compared with movements from Texas, Oklahoma and Kansas. However, the higher costs of products in these areas must be recognized, and proper provisions made for recovery of the higher costs involved.

4. In order that the maximum number of tank cars may be released for and kept in long distance movements, it is essential that the tank trucks which are doing the local work of these tank cars be kept in operation, and that assurance be given that the relatively small amount of new rubber required be made available.

5. Deliveries above current essential requirements should be added to inventories to bring present depleted stocks to necessary levels in anticipation of winter demand for fuel oils.

6. Refineries supplying District 1 should further change their operations as soon as possible to provide additional supplies of distillate fuel oil as well as residual fuels. However, to go further in this direction under present price ceilings (inherited from a period when gasoline was the prime refiner product)

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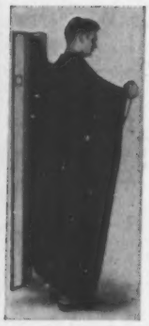

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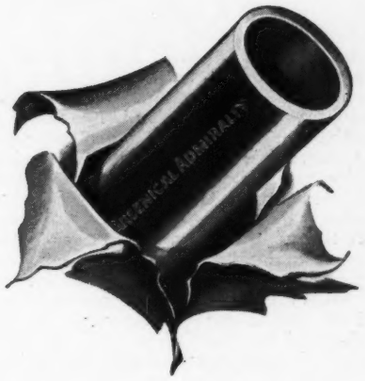

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This alloy was introduced as a result of extensive research work, begun several years earlier, which demonstrated that the addition of a very small percentage of arsenic to the standard Admiralty Alloy materially increased its resistance to dezincification.

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would speedily bankrupt some of the refineries affected, so means must be found to correct the situation promptly before more drastic changes in yields can be expected.

7. It should be pointed out that available transportation facilities are inadequate to move crude or products from District 3 at rates higher than the levels of production recommended by OPC, and that allowables higher than those will necessarily result in maladjustments in the industry and pipe line proration by individual companies.

8. Such tanker capacity as may be available should be largely utilized to make deliveries to New England points in order to permit the most effective use of tank cars on shorter hauls and avoid bottlenecks at New England railway gateways.

9. Since residual fuel oil stocks on the East Coast have reversed their downward trend while gasoline and distillate fuel stocks are still going down, it is important that current and future directive orders be modified so as to produce a balance stock position of all products based on a consideration of future demand.

10. Non-tanker methods of delivery should be still further increased. However, the industry cannot be expected to continue, let alone expand, its heavy out-of-pocket contributions to war service when present price ceilings prevent cost recovery on any of the products it is bringing into the coastal area. Either the government or the public must take care of the excessive wartime transportation costs if such methods are to be fully utilized.

OPC Will Be Corporation Under New Connally Act

What amounts practically to incorporation of OPC, with far wider powers than it now possesses to direct the course of the oil industry and protect it against financial loss, is provided for in a bill introduced in Congress June 1 by Senator Tom Connally of Texas to establish a War Petroleum Corporation with a government-subscribed capital of $500,000,000.

The corporation would be headed by the oil coordinator and would be within his office, but its existence would be restricted to the period of the war and for six month thereafter.

The policy of the organization, as set forth in the bill, would be "to assure, in aid of the successful prosecution of the present war, the maintenance of an adequate supply of petroleum and its associated hydrocarbons, and the products thereof, and the utilization with maximum efficiency of the petroleum resources of the United States, its territories and insular possessions, together with the facilities for making such petroleum and petroleum products available, adequately and continuously, in the proper forms, at the proper places, and at prices not in excess of those established by the Office of Price Administration, to meet military, industrial, and essential civilian requirements."

To carry this policy into effect, the corporation, among other things, would be empowered to cause:

(a) Supplies of petroleum and petroleum products to be delivered in any areas in the United States, its territories, and insular possessions, where the coordinator shall find that there exists an imminent shortage of such supplies to meet military and essential civilian requirements;

(b) The construction, extension, conversion, maintenance, relocation, or more efficient use of any facilities for the transportation or storage of petroleum or petroleum products;

(c) The conduct of refinery operations so as to secure, either generally or in specific instances, necessary amounts of particular petroleum products;

(d) The maintenance of adequate reserves and production of such petroleum and petroleum products as are of strategic importance in quality or location, and

(e) The return to natural underground reservoirs of petroleum or to cause other disposition to be made, upon such terms and conditions as will adequately protect the interests of the United States, of any petroleum products purchased by the corporation for the purpose of assuring the production of other necessary petroleum products.

To carry out the plan set forth, the corporation would be authorized, within the limits of its available funds:

(a) To make loans, if fully and adequately secured;

(b) To purchase petroleum and petroleum products at such prices as the coordinator may determine to be necessary, and to sell such petroleum and petroleum products at prices no higher than those prescribed by the Office of Price Administration;

(c) To pay transportation charges covering the movement of petroleum and petroleum products;

(d) To transport and store petroleum

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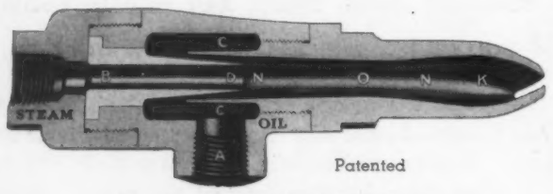

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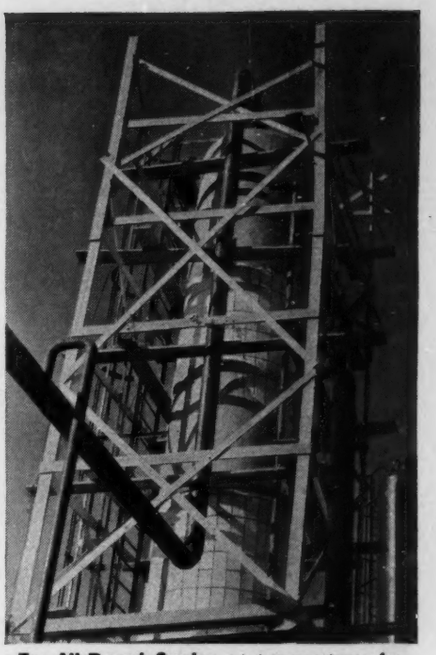

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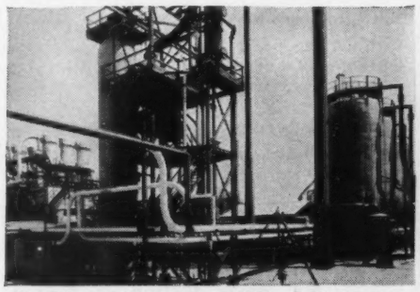
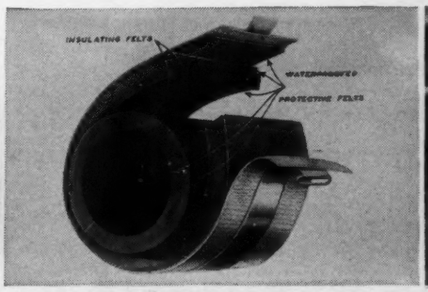


For Steam Lines up to 700° F.—J-M Asbesto-Sponge Felted Pipe Insulation provides high salvage value, unusual durability. 3-ft. sections. Thicknesses from 1" to 3". Integral waterproof jacket for outdoor use.



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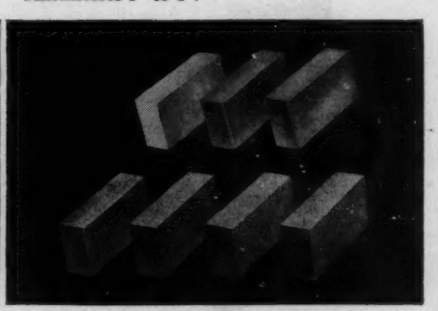

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In this connection, however, the measure provides that "no purchase of petroleum or petroleum products shall be made at prices higher than those prescribed by the Office of Price Administration except where the quality or quantity of such petroleum or petroleum products has been so altered by the producer thereof in response to any direction of the coordinator as to cause the cost thereof to be increased and the amount of such excess over the price ceilings established by the Office of Price Administration which the corporation may pay and the producer may receive shall not exceed the increased cost of such altered production as determined by the coordinator."

In the absorption of increased transportation costs, it is provided no payment for transporting oil or products owned by others than the corporation may be made in an amount which exceeds the difference, as determined by the coordinator, between the rates prevailing on March 1, last, for such movements by normal, pre-war methods of transportation and any increased rates paid or to be paid in response to any direction of the coordinator.

The bill is designed to meet all the needs of the industry occasioned by war dislocation — to compensate the companies for higher transportation costs, to enable the government to purchase distress stocks occasioned by the disruption of transportation facilities, and to permit loans to small operators faced with bankruptcy as a result of the closing of their markets, etc.—while at the same time getting away from the problems which would be involved in the provision of an out-right subsidy.

At his weekly press conference, Coordinator Ickes said there is a "good deal of merit" in the Connally bill, but OPC has not yet been asked to report on it officially.

The bill also came up before PIWC, which took no position on it but decided to gather material for submission to the Senate Finance Committee in the event hearings are held on the measure.

Distribution Plan Stops Cross Hauling

Program has been organized and machinery set in motion to carry out a long-range plan in District 3, as established by OPC, for increasing movement of petroleum and petroleum products from District 3 to District 1, the latter area being mainly the Eastern Seaboard, and to eliminate cross hauling within District 3.

Ralph K. Davies, deputy coordinator of OPC, issued a directive May 29 to Charles F. Roeser, chairman of the general committee of District 3, requesting that the plan be made effective immediately.

The supplies and distribution subcommittee of the general committee of District 3 has, therefore, sent out copies of the plan to refiners and distributors in the areas involved to bring about full compliance with all the provisions. C. B. Barrett is chairman of the subcommittee.

In order to accomplish the plan's objectives, District 3, which is comprised of Texas, Arkansas, Louisiana, Mississippi, Alabama, and New Mexico, is divided into nine refinery marketing areas. Distributors or marketers will not be permitted to move products that are for consumption within District 3 beyond the boundary lines fixed for the area in which the refinery is located. There is one exception to this rule, however, which involves the ninth area, being the states of Alabama, Mississippi, the major portion of Arkansas and the eastern portion of Louisiana. This area is to be supplied by refineries in the area and by refineries located on the Texas Gulf Coast. This exception was made, in part, due to the few refineries in the area.

The whole plan calls for concentration of movement of products in the north and east. No restriction is placed on movements from District 3 to points in District 2, but shipments from District 2 to District 3 are eliminated. The subcommittee decided, however, that six counties in Northwest Arkansas could not be adequately supplied by refineries in District 3, and were assigned to refineries in Oklahoma which is in District 2.

Based upon sales record made by a designated refinery group in District 3 during March, 1942, and upon data on per-capita consumption by states, a territory has been set aside for interior refinery groups large enough to give the designated refinery group its prorata share of consumption within the district.

The supplies and distribution subcommittee proposes that from time to time it will ascertain volume of sales made within District 3 by each refinery group and recommendations for changes in boundaries of marketing areas will be made when it becomes apparent that changes should be made.

In dividing the district into the nine

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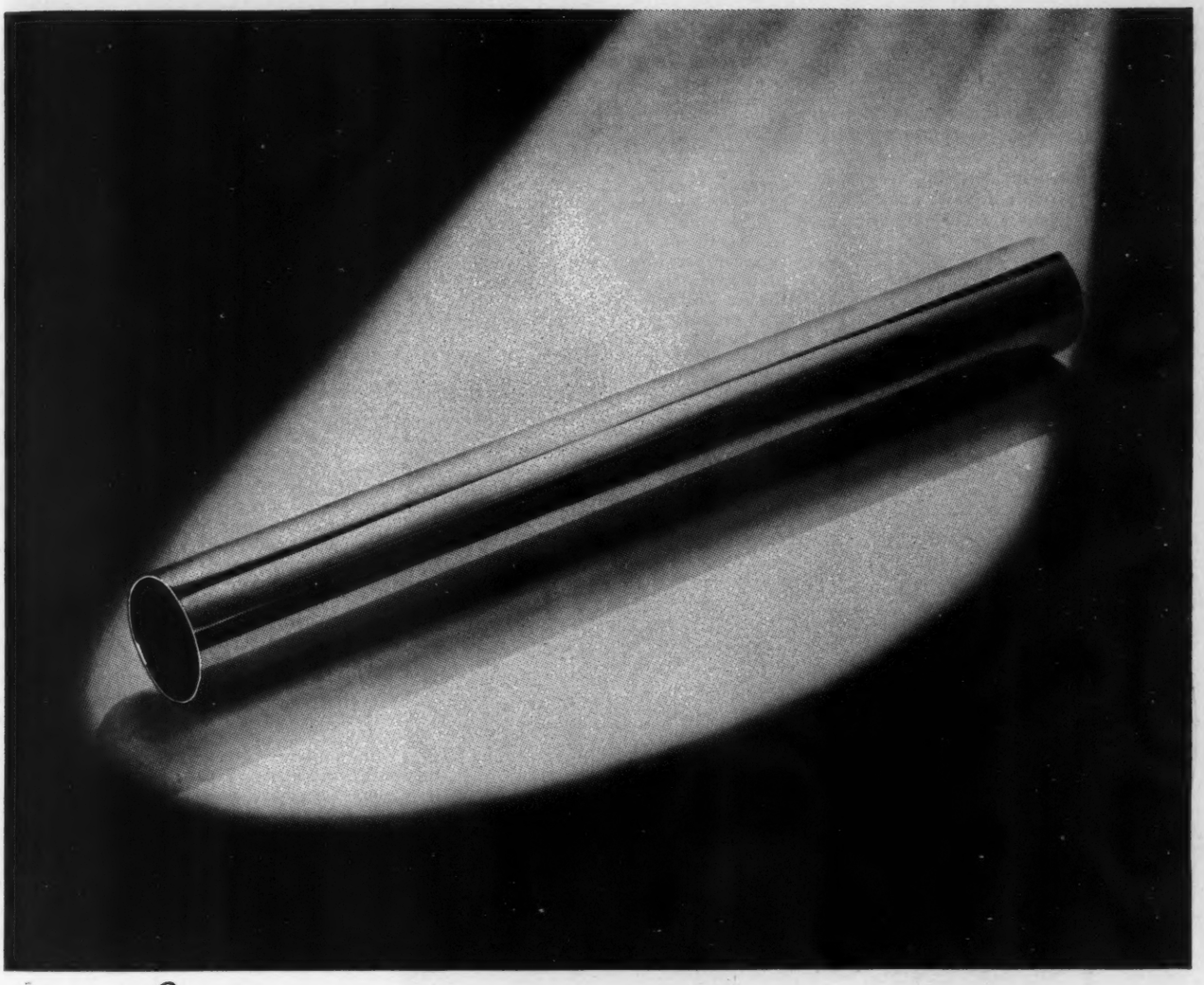

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areas, it was contemplated that the largest portion of any increase in the movement to District 1 would fall largely on refineries in the Houston-Beaumont-Port Arthur area, and not to the Corpus Christi area. As a result, the marketing area assigned to the Corpus Christi-San Antonio area was enlarged to provide for an increase in sales within District 3 for refineries in that area.

Meanwhile, OPC has approved the allocation plan for refinery runs in District 3. Drafted by the district's general committee, the plan calls for the refining committee of the district each month to determine demand for products and allocate it among refineries.

More Units Added for Rubber Ingredients

Both Humble Oil & Refining Company and Phillips Petroleum Company have started work on units for providing ingredients for the synthetic rubber program, which will involve expenditures in excess of $400,000,000 within the petroleum industry.

The Humble program includes units for butadiene, which will go into buna type rubber, and a unit for manufacture of ingredients for the newer butyl synthetic. Phillips will build two units and will provide styrene, one ingredient for the buna type rubbers.

Expenditure by Humble Oil & Refining Company involves $36,000,000, half for the butadiene unit and half for the butyl unit. In addition the company is adding power plant facilities as well as a fluid catalyst unit, which will provide part of the feed for the rubber ingredients units. Each is being built with funds from government agencies. They will be leased by the company and operated under a contract with the Rubber Reserve Corporation. The relationship is similar to that under which the toluol plant, completed last year, is being operated.

The announcement was to the effect that much of the equipment has been bought and that the butadiene unit is under construction.

Upon signing contracts with government agencies the latter part of May, Phillips Petroleum Company gave the following information as to its part in the synthetic rubber program:

"In anticipation of the actual signing of the contracts, Phillips proceeded with the design and planning work some time ago. On the butadiene plant, the company already has the basic designs practically completed, detail engineering well under way, plant site selected, and a large part of materials on order under the highest priority ratings. Design and engineering of the styrene plant are also well advanced and the plant site selected. Both plants will be financed and owned by the government, but operated by the company.

"For many years, Phillips has been carrying on intensive research work on the use of petroleum ingredients for the manufacture of synthetic rubber. Through an affiliate, the company has held a direct interest in the commercial production of synthetic rubber since August, 1940.

"According to Phillips officials, the best solution to our rubber shortage problem, at least so far as military and essential civilian uses are concerned, lies in the manufacture of synthetic rubber from butadiene and styrene. Both of these products can be made in large quantities from petroleum. Phillips is one of the few companies which has large supplies of the necessary ingredients for these products immediately available."

Construction has started on the butadiene unit of the Neches Butane Products Company, which was formed by the Atlantic Refining Company, Gulf Oil Corporation, Magnolia Petroleum Company, The Pure Oil Company and The Texas Company. William H. Hoffman, who has been with The Texas Company, has been elected president. This is the largest unit announced so far in the synthetic rubber program, with $60,000,000 the estimated cost.

WPRA Conference On Specifications

Specifications was the subject of a symposium by the technical group of Western Petroleum Refiners Association in the Washington-Youree Hotel, Shreveport, June 12.

The subject was divided into three divisions: gasoline specifications, A. W. Trusty, chief chemist, Arkansas Fuel Oil Company, chairman; lubricant specifications, H. J. Sheard, superintendent, Bayou State Oil Corporation, chairman; fuel oil specifications, W. M. Carney, chief chemist, Lion Oil Refining Company, chairman.

An open-forum discussion followed and J. K. McKinnon, manager of Talco Asphalt & Refining Company was chairman of the general meeting.

(Above) Roto Model 105 motor with chain joint and drill head for superheater tubes.

(Right) Roto Model 125 motor with long 4-arm head for curved tubes.

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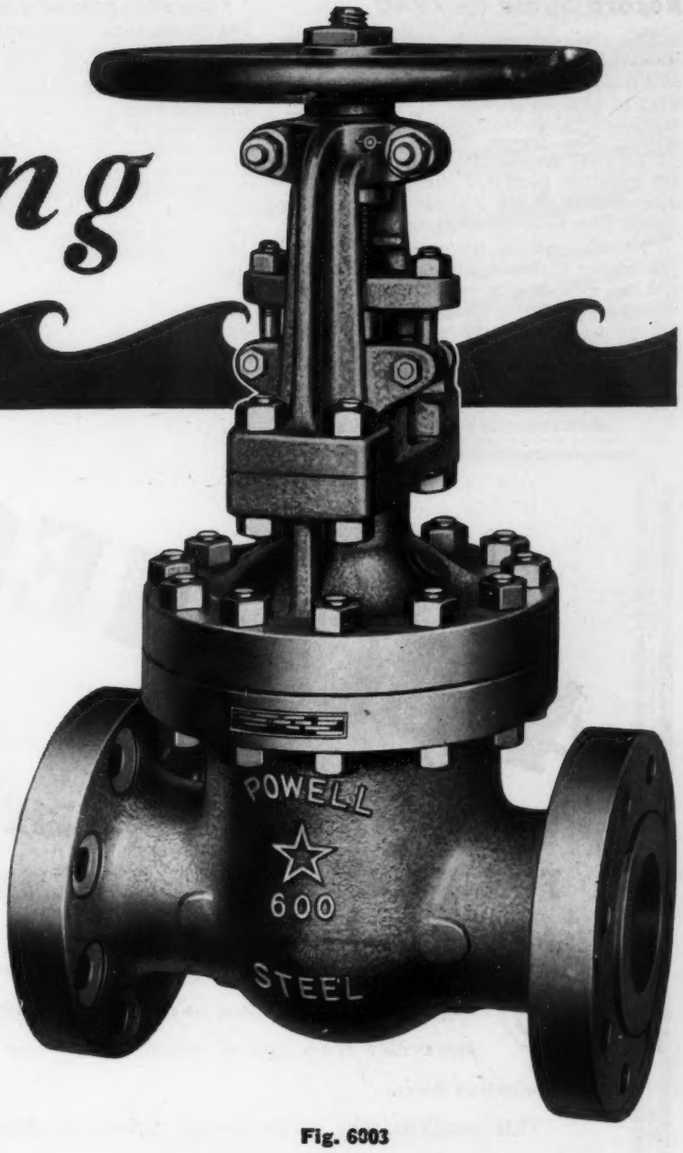

Fig. 6003

An ideal valve for the Oil Industry—a 4", Class 600 pound Cast Steel O. S. & Y. Gate Valve with flanged ends. Outside screw rising stem. Sizes range from 1" to 24". Can also be equipped with by-pass and motor operators. Sizes 6" and larger are regularly furnished with anti-friction bearing yoke for smoother, easier operation.

This is one of a complete line of valves designed and built by Powell to meet the Industry's demand for positive, dependable flow-control.

The steady, irresistible flow of American War Production is what makes it invincible. The flow of the liquids and gases that play such an important part in all modern production, to be effective, must be perfectly controlled. To keep them flowing under perfect control is our job. We have been at it just four years short of a century. During that time we have met and overcome many a problem concerned with the controlled flow of the fluids of industry.

The Powell line is a collection of valves which have been built to order, each to do a special job. The Powell engineering staff, in the solution of new problems, year after year, have built up the Powell line valve by valve. Today it covers the full range of industry's needs. Tomorrow it will do the same. For industry's problems are our problems and we are ready and able to work them out. When you think of the liquids and gases of industry, and how to control them, think of Powell.

The Wm. Powell Company
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POWELL VALVES

Petroleum Accident Record Same as 1940

The accident record of the petroleum industry for 1941 held at the same levels as for 1940, according to the annual report of the department of accident prevention of the American Petroleum Institute. The report, "Annual Summary of Injuries in the Petroleum Industry for 1941," is available through its headquarters, 50 West Fiftieth Street, New York. The summary follows:

"Petroleum-industry employes worked just about as safely during 1941 as they did in 1940, despite widespread national defense activities, the advent of war, numerous changes in employment, and many new employes, according to the annual report of the American Petroleum Institute's department of accident prevention.

"Records of 172 companies employing 333,122 persons, who worked nearly 700,000,000 hours in 1941, indicate that the severity of injuries was unchanged from 1940, and that the frequency of injuries increased only 1.6 percent from the all-time low in 1940. Although other records are not yet published, it is believed that this safety record is substantially better than the average for all industries last year. For the past 10 years the petroleum-industry record has been below, or close to, the all-industry average.

"The index of injury frequency for all branches of the petroleum industry was 11.78, a decline of more than 60 percent since 1929. The injury severity index, 1.44, was more than 40 percent below the 1929 level. Frequency rate is the number of disabling injuries per million hours worked; severity is the number of days lost per thousand hours worked.

"The composite injury index for the industry was 26.18 last year, compared with 25.99 in 1940, and 51.68 in 1929.

"Indicative of the industry-wide causes of the increase in accident frequency is the fact that all branches of the petroleum industry except pipe lines showed a slight increase. Pipe-line employes record a marked decrease in frequency of accidents, and an even greater decline in the severity of accidents.

"Lowest frequency rate, 8.45 accidents per million hours worked, was established by refinery workers. Marketing employes had the lowest severity index, 0.65 days lost per thousand hours worked."

ALKALIES

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Perhaps you as a refiner of petroleum, do not realize that alkalies are a factor in nearly all industries—*practically every one of which is on a war time production basis.*

This explains why, even though Solvay is America's largest producer of alkalies, it cannot always supply full alkali requirements of the many Solvay customers who manufacture other than war materials.

Yet, as fast as changeovers can possibly be made, we are *increasing* production of important alkalies and related products to meet war time needs. At the same time, it is possible that Solvay Technical Service may prove helpful in finding a solution to problems arising from material shortages. Inquiries are invited.

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Officials of Copper and Brass Association

Robert L. Coe, vice president of Chase Brass & Copper Company, Inc., Waterbury, Connecticut, was elected president of the Copper & Brass Research Association at its twenty-second annual meeting in New York, May 22. He succeeds John A. Coe, president of The American Brass Company, Waterbury, Connecticut.

Vice presidents are: John A. Coe, The American Brass Company; Wylie Brown, Phelps-Dodge Copper Products Company; R. E. Day, Bridgeport Brass Company; C. L. Smith, The National Copper & Smelting Company and William M. Goss, Scovill Manufacturing Company.

Other officials are: C. Donald Dallas, Revere Copper and Brass, Inc., treasurer; T. E. Veltfort, manager; Bertram B. Caddle, secretary.

The board of directors consists of John A. Coe, Wylie Brown, R. E. Day, R. L. Coe, William M. Goss, C. L. Smith, C. D. Dallas, T. E. Veltfort, B. B. Caddle, J. A. Couchett, A. W. Wilkinson, S. H. Perry, Otto Z. Klopach and F. L. Riggins.

The organization has headquarters at 420 Lexington Avenue, New York.

Elimination of Oxygen Waste

As part of a campaign against waste of oxygen in welding and cutting operations, two posters for display in plants where oxyacetylene processes are used have been made available. Both posters dramatize oxygen's importance to war production and emphasize the need for its conservation. Eye-catching colors and illustrations give both pieces high attention value.

No advertising appears on either poster. Light weight paper stock permits easy mounting anywhere in the shop. Write for free copies which will be sent postpaid in any quantity desired. Address G. Van Alstyne, Air Reduction Sales Co., 60 East 42nd Street, New York.

Gasoline Consumption Up 11 Percent in 1941

Consumption of gasoline in 1941 showed a gain of 11 percent in 1941 compared with revised figures for consumption in 1940. The information released by the American Petroleum Institute follows:

"Alabama, Texas, and Virginia reported the largest consumption gains,

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1942 marks Graver's 80th year in serving industrial America with steel plate equipment for many uses.

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Just an infant in 1862, we have grown and developed with America — shared its problems and the solving of them — used each new experience as a stepping stone toward greater service to mankind and industry.

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We are proud to have grown up with America — proud to have contributed to the building of the greatest nation on earth — and we are glad that we are continuing to contribute our utmost in helping America fight to preserve freedom.

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In these critical times it is difficult to serve all of those whom we would like to serve, but our Government's needs must be supplied as quickly as possible. Here at Graver this will be done, and we hope that peace will soon return that we can again serve Industry with steel plate equipment as needed — and when needed.

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but one third of the states showed increases of more than 15 percent. New York, with a gain of 4.4 percent, was the only state which had less than a 5-percent consumption increase.

"Total 1941 consumption reported to the institute's department of statistics amounted to 26,874,821,000 gallons. Revised figures for 1940 show consumption of 24,125,627,000 gallons in that year.

"California and New York led all states, as they have in prior years, with total consumption of 2,241,085,000 and 2,058,071,000 gallons respectively. Six other states — Illinois, Michigan, New Jersey, Ohio, Pennsylvania, and Texas— used more than a billion gallons last year. Altogether these 8 states accounted for 13,354,002,000 gallons, or half of consumption for the entire country.

"The table reveals that the 17 states and the District of Columbia which comprise the Petroleum Coordinator's District 1, the East Coast curtailment area, consumed a total of 9,601,387,000 gallons of gasoline in 1941, or about 36 percent of the United States total.

"Consumption figures, given by states and months in the table, indicate that more gasoline was used in August and less in February, than in any other months. The report cautions that figures were compiled from data supplied by departments of the various state governments, and in general are based upon returns made in accordance with gasoline tax or inspection laws. However, the figures reflect, as far as possible, total consumption, including both taxable and tax-exempt gallonage."

Gasoline Demand to Have Sharp Decline

Although transportation improvements may relieve the East Coast oil supply situation sufficiently that rationing might be eased or perhaps lifted, however, the rubber shortage is to be a permanent condition as long as the war lasts. No tires for civilians are likely. Consequently, a steadily declining consumption of gasoline is in the cards even if all rationing proves a temporary thing, which means additional problems for petroleum.

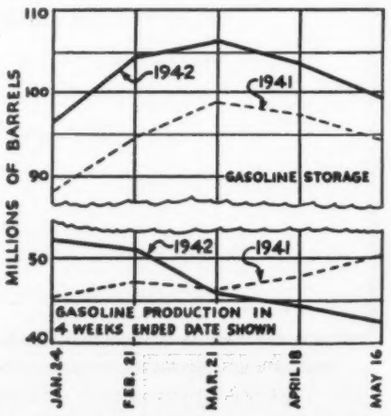
The rubber shortage means vehicles will go out of use, causing a corresponding reduction in motor-fuel demand. Furthermore, some decrease in consumption will result from less and more careful driving, although this will postpone the time when a car is forced off the road.

Assuming the worst possible conditions, that there will be no rubber at all, even for recapping purposes, Dr. C. L. Burrill, director of the statistical division of the Department of Economics for Standard Oil Company of New Jersey, has made the following estimates on future passenger vehicle use and gasoline consumption:

Year	No. Passenger Cars In Use	Barrels Gasoline Used Yearly
1941	28,000,000	428,000,000
1942	28,000,000	354,000,000
1943	25,200,000	290,000,000
1944	17,700,000	161,000,000
1945	6,800,000	52,000,000
1946	1,400,000	5,000,000

The above estimates apply only to the 28,000,000 passenger cars. The remaining 6,000,000 vehicles (chiefly trucks) will use more gasoline, and export and aviation gasoline requirements will be greater. Therefore, the overall demand for motor fuel in the next five years is not as dark as the above figures indicate. Dr. Burrill figures that 1944 total demand for gasoline will be 83 percent of 1941 requirements, 1945 will be 69 percent of 1941, and 1946 will be 64 percent.

However, this still remains an extremely serious situation unless some way is found to obtain additional rubber supplies, or unless the war ends



Although production of gasoline during 1942 already has fallen from an early level well above 1941 rates to a position substantially less than a year ago, stocks of this product have been reduced at but normal speed. This indicates the sharp shrinkage that has occurred in gasoline consumption, which is due to become more severe in the coming summer months because of rationing and lessened vacation automobile travel.

PIPEWRENCH PETE SAYS:

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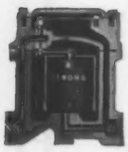
WAR!

Strong Specialties are now needed for war plants (explosives, chemicals, aircraft, ships, etc.) PLEASE CONSERVE present Strong equipment. Use repair parts to restore efficiency . . . increase production . . . save steam (fuel) . . . save money.

Steam costs money. The "big shots" know it. And when their new battery of cookers uses 27% LESS, they want to know why. I'm still wonderin' why they gave me an office with my name on the door for tellin' them plain horse sense like this:

STRONG 70-T TRAP



For quick-heating cookers, etc. Lets out all the air. Shuts tight soon as steam hits it. Can't dribble because of the exclusive antibalancing device. Packs as much quality as Strong's larger inverted bucket (80 series) trap. Guaranteed a year.

STRONG 30 REGULAR TRAP

For any drainage job, particularly separators, headers, engine manifolds. Install one and watch it work. You'll still be patting yourself on the back 10, 15 years from now, on account of the ANUM-METL valves and seats and wear-proof parts.

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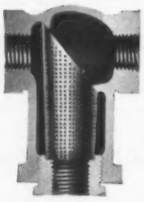
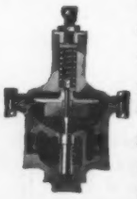


Makes reducing valves, traps, controls, etc., live longer and work better, by taking out scale, dirt, grit or sand. Just open the blow-off to clean it.

STRONG REDUCING VALVES



Type K of complete line shown. Name your own reduced pressure from 85 pounds down, and this valve keeps right on giving it to you. ANUM-METL valves and seats guaranteed for a year.

HOW DO YOU SIZE STEAM TRAPS? Easy method, plus valuable information on installations, etc. Send for Catalog 63-R1.
Write for name of your nearest distributor.

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THIS is the number of c. c. of tetraethyl lead, a critical war material, saved per operating year by a refiner of MICHIGAN crudes, treating cracked and straight run gasolines in a Gray Catalytic Desulfurization Unit.

By using the Gray Catalytic Desulfurization Process this refiner almost completely removes mercaptan sulfur and greatly reduces the non-mercaptan sulfur in the gasoline treated.

By such desulfurization he saves 1.23 c. c. of tetraethyl lead per gallon of 70 octane number finished gasoline in an operating year conservatively estimated at 320 days, a total of 31,409,280 c.c.

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before 1944. Other countries less dependent upon automobile transportation had great difficulty when rubber became scarce. The situation in the United States would be many times worse. Vast dislocation of oil is indicated also. Refiners will be forced to adjust yields so less gasoline and more heavy fuel is obtained. Considerable crude will have to be deliberately converted into fuel. Refineries manufacturing aviation gasoline, blending agents, toluene and other special war products will have to have adequate gasoline outlet to maximize the output of these products. Therefore, nationwide equitable adjustment of refinery yields will not work. Some plants and regions will have to adjust more than others.

Increased Butane Recovery Possible

By altering operating procedure of the fluid catalyst cracking process of Standard Oil Company of New Jersey the butane supply for feed stock to butadiene units can be substantially increased. In announcing this development, W. S. Farish, president of the company, said the quality of 100-octane-aviation gasoline could be improved as well.

Although full details of operation can not be made public, the change in technique is known to consist of raising the temperature of the process without materially changing pressure. It is likely that similar changes can be applied to other catalytic processes.

The fluid catalyst process was made public last year, after going through the pilot plant stage by Standard Oil Development Company. Units are now under construction and one will be in operation the latter part of this year.

The announcement follows:

"A new procedure whereby synthetic rubber raw materials and an improved quality of 100-octane-aviation gasoline can be produced simultaneously has been worked out by Standard Oil Development Company, our technical organization. All details, based on experimental plant experience, have been supplied to the petroleum coordinator and other government agencies. The new method will be generally available under the system of licenses now being used in the oil industry which system has the approval of the petroleum coordinator.

"We estimate that adoption of the new method will speed up the war program for production of synthetic rubber from plants already under way and will provide the nation with an increased potential capacity of raw material for more than 400,000 tons of Buna S rubber and 240,000 tons of Butyl rubber a year.

"Synthetic-rubber raw materials can be produced in plants now under construction by refiners for the production of greatly increased quantities of 100-octane-aviation gasoline. Portions of these plants, being built at a cost of $120,000,000 can, with the new procedure, perform a dual role by turning out the expected production of 100-octane gasoline and, at the same time, produce raw materials for synthetic rubber.

"We understand that the present government program calls for production of 800,000 tons of synthetic rubber a year, 700,000 tons of which is to be Buna S rubber, 60,000 tons Butyl rubber, and 40,000 tons neoprene. A prime bottleneck in this program has been the construction of plants to produce synthetic rubber raw materials.

"Benefits of the new procedure are three-fold:

"1. We formerly believed that any large production of raw materials for synthetic rubber by oil refineries would automatically reduce the output of 100-octane gasoline, which is essential to our rapidly growing force of fighting planes. This possibility can now be averted.

"2. The new process sets up a large potential supply of needed raw material for synthetic rubber. We use the term 'potential' because the amount of synthetic rubber raw material actually to be drawn from these operations will depend upon how requirements for 100-octane gasoline and synthetic rubber are balanced by the war agencies. That is, the synthetic rubber raw material produced by the new procedure might also be used for increasing the quantity and further improving the quality of fighting grades of aviation gasoline.

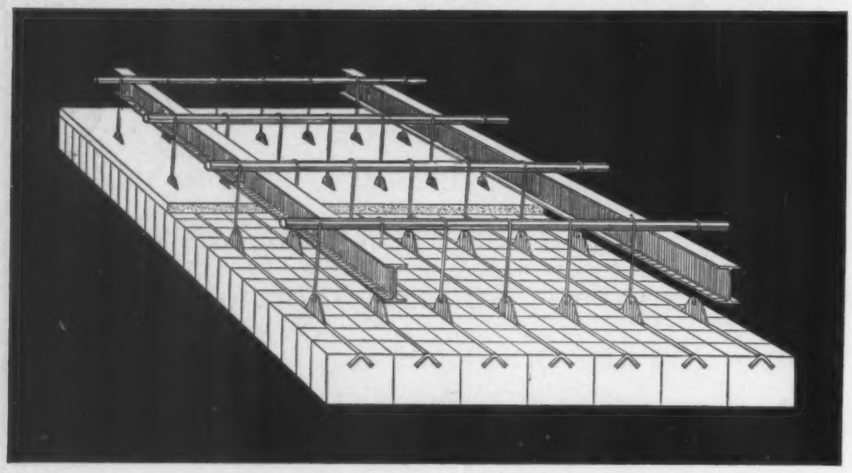
"3. The new procedure produces an improved quality of base stock for aviation gasoline, which will give our fighting planes more power in take-off and under other flying conditions requiring full engine throttle. Formerly, to have achieved this improvement in quality it would have been necessary to reduce output. The new procedure eliminates this necessity. Some refining units will use it actually to increase output of 100-octane-aviation gasoline.

"The new procedure was discovered

THE SUSPENDED ARCH

...and why it should be built with

LIGHTWEIGHT ARMSTRONG'S REFRACTORIES



UTMOST SIMPLICITY keynotes this suspended arch designed by the Refractories Division of the M. W. Kellogg Company, Jersey City, N. J. Note how each arch hanger is supported by two hooks which depend from standard steel pipe. This permits movement, yet keeps the hanger level so that brick do not tilt or become subject to excessive strains.

TODAY, all over the country, you'll find lightweight cracking furnaces built and building with suspended arches and walls of Armstrong's Insulating Fire Brick. Important advantages of the suspended arch construction shown above are:

SIMPLICITY OF DESIGN: This arch was planned for fast, low-cost erection. Only a few shapes are used and all are cut from standard Armstrong's Brick which are small and easily handled. The machined surfaces, and true corners and edges assure thin, heat-tight joints.

LIGHT WEIGHT: These lightweight brick permit construction savings through lighter steel work . . . lighter foundations and footings.

OPERATING EFFICIENCY: Armstrong's Insulating Refractories are extremely efficient, cut fuel costs, and help control temperatures. In addition, they have high spalling resistance, exceptional hot and cold strength, and low heat storage. The brick can be cut, notched, or grooved right on the job. No large inventories of special shapes are needed for replacements.

For the facts about lightweight constructions write Armstrong Cork Company, Insulating Refractories Dept., 1001 Concord Street, Lancaster, Pa.

ARMSTRONG'S INSULATING REFRACTORIES

through experimental operation of a pilot plant, and in normal times we would withhold details of the discovery until the process had been proven in full-scale plant operation. However, in view of the urgent war needs of the nation, and the fact that the first full-scale plant using this procedure will not be ready for operation until next August or September, we are releasing immediately all experimental data for the use of others constructing similar plants.

"In view of the country's urgent need, our government is making an intensive effort to determine the means by which synthetic rubber can be produced fastest and with the least possible drain on critical materials for plant construction. Our foremost objective is to contribute in whatever way we can to a quick and satisfactory solution of the problem.

"Earlier this month, we gave to the Secretary of Agriculture all information in our possession which might be helpful to the production of synthetic rubber from grain alcohol, and kept Senator Guy Gillette of Iowa and the Agriculture Sub-Committee informed of our readiness to assist. We are sure that sound decisions will be reached. We must have synthetic rubber and must get is quickly, whatever the means—whether we make it from petroleum or from grain alcohol, or both. That is all that really matters."

Cooperative Research Council Is Formed

Representatives of the petroleum industry and the automotive industry have formed the Cooperative Research Council, whose duties will supplant the work formerly done by the Cooperative Fuel Research Committee, which has functioned for 21 years. The new council was formed by the American Petroleum Institute and the Society of Automotive Engineers.

Six members from each organization are members of the council: D. P. Barnard, Standard Oil Company (Indiana); A. L. Clayden, Sun Oil Company; T. G. Delbridge, The Atlantic Refining Company; R. A. Halloran, Standard Oil Company of California; K. G. Mackenzie, The Texas Company; G. G. Oberfell, Phillips Petroleum Company; B. B. Bachman, Autocar Company; J. M. Crawford, Chevrolet Division, General Motors Corporation; William Littlewood, American Airlines, Inc.; J. B. Macauley, Jr., Chrysler Corporation; Arthur Nutt, Wright Aeronautical Corporation, and C. G. A. Rosen, Caterpillar Tractor Company.

Bachman was named chairman with Delbridge, vice chairman. C. B. Veal, research manager of the Society of Automotive Engineers and secretary of the CFR comimttee, has been appointed secretary with Dr. R. P. Anderson, secretary of the Division of Refining, American Petroleum Institute, treasurer. Headquarters have been established at 30 Rockefeller Plaza, New York.

Announcement of the council through the American Petroleum Institute gave outline of its functions:

"Automobiles, airplanes, tractors, and other vehicles of the future will operate better because of the work of a new organization which will coordinate the research activities of the automotive, aeronautic, and petroleum industries.

"The best combinations of fuels, lubricants, and equipment powered by internal-combustion engines will be sought by the new group, the Cooperative Research Council. The council, which is sponsored by the American Petroleum Institute and the Society of Automotive Engineers will continue the work of the Cooperative Fuel Research Committee. The CFR committee has done effective research on fuel utilization for 21 years, and its work has been of major importance in the development of automobile and airplane engines and fuels to their present state of perfection.

"Other council groups which will centralize, correlate, and promote cooperative research within these industries include a cooperative lubricants research committee, a cooperative equipment research committee, and a war advisory committee. The latter will work with government and military agencies in solving fuel and lubricant problems. The council will not issue any standard methods of test, specifications, or classifications. These already are the function of existing agencies."

Channock Is Treasurer of National Refining Company

R. E. Channock has been elected treasurer of National Refining Company, Cleveland. He has been assistant treasurer for the past two years. He joined the company in 1926 and has served as internal auditor, traveling auditor, tax expert, head of the general accounting department and assistant secretary and treasurer.

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DIGEST OF FOREIGN LITERATURE

HEINZ HEINEMANN

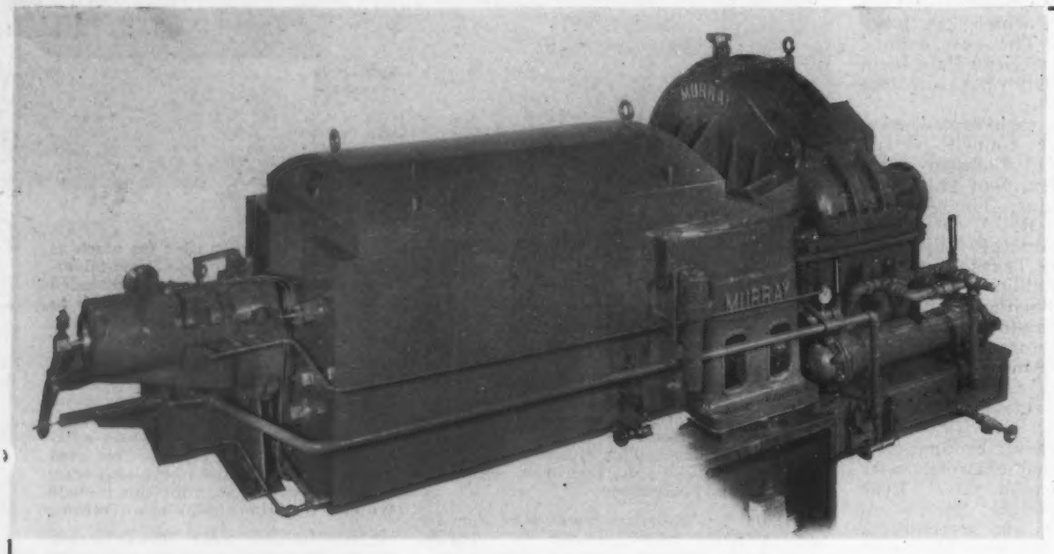
Recent German publications give considerable space to articles concerning utilization of the limited fuel resources within Axis territory. G. Coppa-Zuccari discusses "The Natural Gas Production and Utilization in Florence," Italy (Oel und Kohle 37, 42, 862). The development of the production of natural gas in the neighborhood of Florence is discussed and an increase in the amounts produced is described. The compression method is used for liquid fuel production.

R. B. Behrmann speaks of the "Geological Development of Albania" (Oel und Kohle 37, 43, 875). The only producing Albanian oil field at this time is the Devoli field. About 670,000 tons of crude oil have been produced in Albania since 1926, 85 percent of which has come from Devoli. The article contains geological sketches of the Devoli area.

"Hydrocarbon Solvents from Petroleum and Their Industrial Applications" is discussed by F. N. Harrap and E. B. Evans (Journal of the Inst. of Petroleum 27, 215, 369). A general description of the commonly available petroleum solvents and the way in which they are used is given by compilation. The chief solvents now available comprise a range of six special boiling point spirits, pool rubber solvent, pool white spirit and pool distillate. The manufacture, specifications and properties of these petroleum solvents are described. The applications of the petroleum solvents indicated in the paper comprise the extraction of oil-seeds, perfume, other extracting processes, glue manufacture, dry cleaning, leather processing; deposition processes relating to the rubber industry, cellulose lacquers, paints, varnishes, printing inks, the manufacture of polishes and miscellaneous applications are described.

In the series, "Progress in Petroleum Technology," M. E. Kelly gives a survey of the "Catalytic Isomerization of the Paraffins" (Fuel in Science and Practice, 20, 8, 184). The development in the catalytic isomerization of petroleum hydrocarbons, invented in Russia over 6 years ago, appears at present to be following two main directions, of which the one is concerned with isomerization as the main reaction (as in the conversion of n-butane to i-butane) and the other with isomerization occurring simultaneously with other extensive reactions (as in the catalytic cracking processes). In the latter case, isomerization involves mainly the olefinic hydrocarbons formed in the cracking reaction. According to Russian chemists approximately 74 percent i-butane may be obtained from n-butane in static liquid phase, using a catalyst of $CuSO_4$, $AlCl_3$ and HCl. Results of other processes, employing vapor phase and recycling are given. When isomerizing higher paraffines by means of $AlCl_3$ decomposition occurs as a side reaction.

A new method for the determination of equivalent cracking conditions for commercial cracking reactions is described by S. L. Neppe (Journal of the Inst. of Petroleum, 28, 218, 27). The writer has found a new method for the correlation of equivalent cracking conditions (temperature and time) during any cracking operation. He summarizes the new points found by him as follows: "(1) A chart is given, showing that a straight-line relationship exists between the factor F_t for which velocity of cracking is doubled and the cracking temperature t. The relation can be expressed as $F_t = 0.04t - 10$. (2) An equation has been derived from theoretical considerations. This very closely defines the relation between time of cracking and temperature for ordinary commercial cracking under constant pressure for a definite yield of product. (3) Another chart has been drawn which can be utilized in a most simple manner for converting cracking conditions at any one temperature or period into equivalent cracking conditions at any other specified temperature or period." The effect of pressure is not discussed in the paper, the assumption being made that the theory is independent of the pressure, the primary importance of high pressure in cracking being thought to



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be the avoiding of evaporation. The results of former investigators are shown and proof is submitted that a straight-line relationship is the most reasonable reflection of the position.

Analysis

J. Goubeau treats the optical analysis of gasolines in two articles. In "Raman-Spectral-Analysis of Hydrocarbon Mixtures" (Oel und Kohle 37, 41, 840) the author shows that Raman spectra are extremely valuable for the analysis of hydrocarbon mixtures. Many comparative values are given.

In "The Optical Analysis of Gasolines" (Brennstoffchemie, 23, 1, 1) tables, covering numerous investigations with Raman spectra are given and compared. Good checks to results which have been obtained by other methods of analysis are shown.

Asphalts and Lubricants

A. F. Dudenko discusses "Asphalts From Cracked Residues" (Vostochnaya Neft 1940, 1, 28; Chem. Abstr.). Cracked residues originating from various Russian refineries were converted into asphalts (on a laboratory scale) by vacuum distillation, blowing with air and by both processes. Vacuum distillation at a residual pressure of 35 to 50 mm yielded in some instances satisfactory asphalts, depending on the origin of the raw material the yields of the final products being 30-60 percent. The distillation was accompanied by sepn of SO_2 particularly at higher temperatures. Steam distillation (superheated to 280 to 290°) produced asphalts of unsatisfactory grade and moreover heavy emulsions which were difficult to break were formed. In the blowing with air the raw material was first heated to 250° and then blown with cold air. The reaction is exothermal. The best temperature is 300°, although even then the product had a very high softening point but an unsatisfactory ductility. Best results with respect to quality as well as yields are obtained by combining all three methods in the following order: steaming, vacuum distillation and blowing with air. The operating conditions (temperature, degree of vacuum, amount of air blown) depend entirely on the raw material used. The oil fraction obtained in the process can be used as cracking stock. The results are tabulated.

"Improving the Efficiency of Lubricating Oils" is the title of a paper by A. H. Stuart (Fuel in Science and Practice 20, 8, 178). A review is given of polar and nonpolar lubricants, compounded lubricants and graphited lubricants for the purpose of ameliorating the lubricating properties. An addition of a little of a high fatty acid with straight chain such as palmitic acid to mineral oils gives good results, as is shown by diagrams. The addition of anti-oxidation, anti-sludge and anti-corrosion agents is also discussed as is that of pour-point depressants, rendering unnecessary the expensive de-waxing of oils which may impair its lubricating properties.

The same author describes "Lubrication Without Oil" (Fuel, 5, 1, 9). The use of colloidal graphite is recommended for cases of oil-supply failure and for bearings which run at very high temperatures.

Refining of lubricating oils is the subject of a paper by M. Freund and G. Nyul on "The Manufacture of Mineral Lubricating Oils by Selective Deparaffination" (Oel und Kohle, 37, 42, 859). Narrowly cut vacuum fractions of a paraffin containing mixed-base mineral oil residue are subjected to selective deparaffination by means of solvents. A good separation of naphthene-base and paraffin-base lubricating oil components was obtained on account of the differences in pour point.

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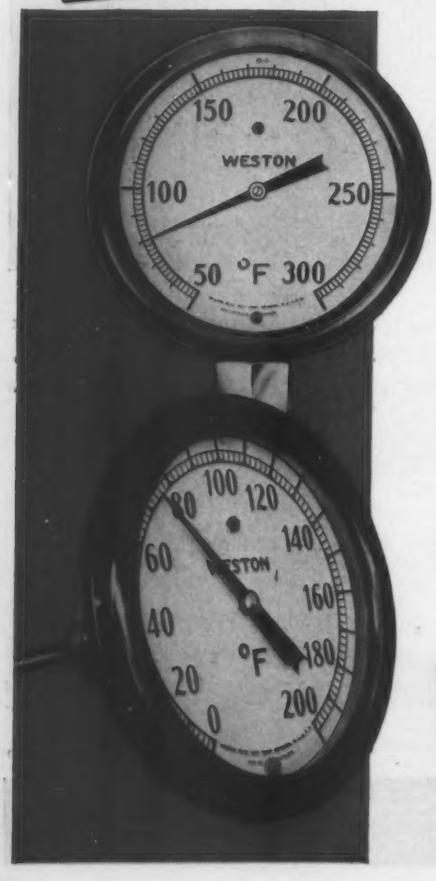

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Arno C. Fieldner Will Get Award

Arno C. Fieldner, chief of the technologic branch and chief of the coal division, United States Bureau of Mines, has been awarded the Melchett medal by the Institute of Fuel of England. He has been in the Bureau of Mines for 35 years and is the second American to receive the award since it was set up in 1930. The other citizen of the United States was the late Charles M. Schwab.

Ordinarily the medal is presented personally in London in October of each year. This year, however, arrangements will be made for the presentation in the United States.

Coghill Now at Washington Post

Robert Webb Coghill has joined the Board of Economic Warfare in Washington as senior petroleum analyst. Formerly he was with Cooper Petroleum Company, Houston.

How to Convert EXISTING Storage Tanks

into Efficient Vapor Saving Units for Handling Volatiles

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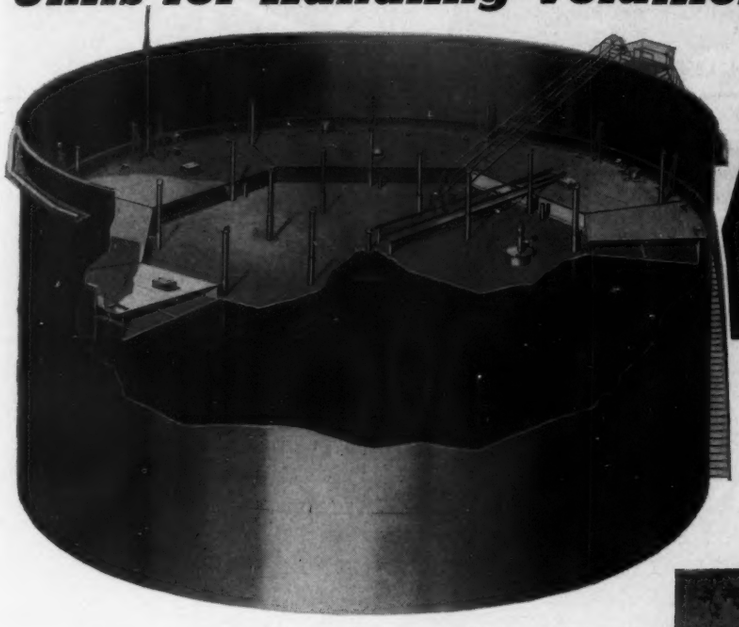
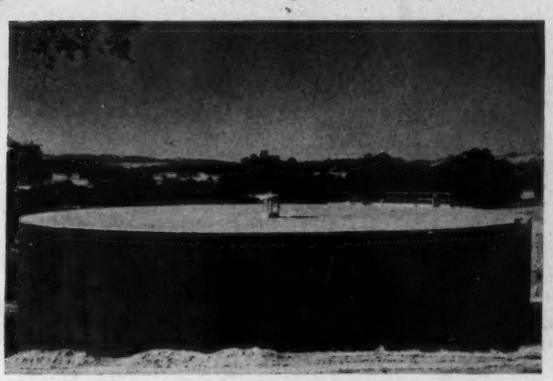
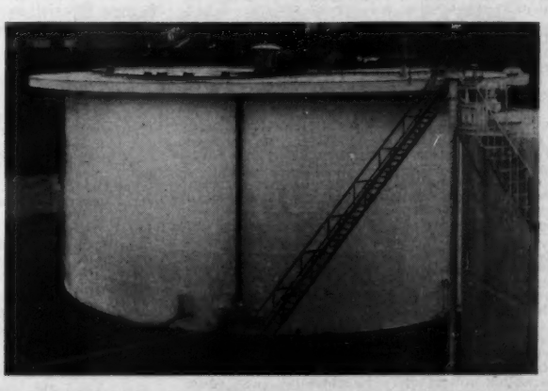


• *At the left is a cutaway view showing the construction of a Wiggins Pontoon Roof on a butt welded tank.*

Directly below is a 115 ft. diam. breather roof which was installed on an existing crude oil storage tank. At the bottom is a new balloon roof which has been installed on a 78 ft. diam. gasoline storage tank.





If you are confronted with the problem of storing and handling increasing quantities of aviation gasoline or other volatile oil products, it is important to remember that the installation of completely new tankage to prevent volumetric loss is not always necessary. For example, if you have existing tanks whose shells are in good condition, one of the simplest, most economical methods of protecting volatiles that do not boil at atmospheric pressure against vapor loss would be the installation of Wiggins Pontoon, Breather or Balloon Roofs on these units.

- **Pontoon roofs are applicable to riveted, lap welded or butt welded tanks 15 ft. in diam. or larger handling aviation fuel, motor gasoline or crudes.**
- **Breather roofs are recommended primarily for standing storage tanks larger than 60 ft. in diam. which remain filled, or nearly so, most of the time.**
- **Balloon roofs are recommended for tanks of all sizes which are filled or emptied not more than six times a year.**

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SCIENCE AND TECHNOLOGY

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by

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under the supervision of
DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical and Chemical Data

Specific Gravity of Petroleum Oils by the Falling Drop Method, A. J. HOIBERG, *Ind. & Eng. Chem.*, Anal. Ed. 14 (1942) pp. 323-5.

A method of densimetry that has shown many advantages in determinations with body fluids has been modified to adapt it to the measurement of the specific gravity of petroleum oils. The operation is rapid and easy, since the procedure depends only on the measurement of the time of fall of a drop of oil in an alcohol-water solution. The specific gravity is then determined by direct conversion of the time of fall from a calibration curve for the solution. The method has been found accurate to within $\pm$ 0.0010 unit of specific gravity. Only a few drops of the petroleum fraction are required for the determination. This is important, because in many instances only very small volumes of oils are obtained in analytical distillations or extractions. The apparatus used and method of procedure are described in some detail. A tabulation of data is included that gives a comparison of determinations of densities by the pycnometer and falling drop method.

Solubility of Polybutene in Pure Solvents, H. C. EVANS AND D. W. YOUNG, *Ind. & Eng. Chem.*, **34** (1942) pp. 461-6.

During the past several years interest in the preparation and properties of long-chain polymers has increased because of their importance in the manufacture of improved petroleum products, plastics, and chemically-resistant paints. Materials such as polybutene and rubber form solutions, the viscosities of which increase rapidly with concentration. In view of the viscosity data published on polyvinyl chloride, polyoxyethylene glycols, and polybutene, an investigation was started to study the degree of solubility of the polymer polybutene. A limited study was made of the solubility of polybutene in sixty pure solvents at room temperature. By the use of the specific viscosity constant, at a concentration of 10 grams of polymer per liter, the degree of polybutene solvation has been calculated for 34 solvents. The viscosity number of the polymer solutions over the approximate concentration range of 10 to 80 grams per liter was measured. Log N has been found by this method not to be a linear function of concentration in the higher concentration ranges of polybutene. It is indicated that chlorinated solvents having dielectric constants greater than about 8 will not dissolve high-molecular-weight polybutene at room temperature. The experimental procedure is described in some detail, and the results of the work are presented in several tables and charts.

Characteristics of Liquefied Petroleum Gas that Affect Its Fire Hazard, M. B. ANFENGER AND O. W. JOHNSON, *Proc. Am. Petr. Inst.*, 22nd Ann. Meeting, Sect. I, 22 (1941) pp. 50-3.

Liquefied petroleum hydrocarbons can cause explosions by development of high pressure due to increased temperature, or by ignition within closed spaces of mixtures with air that fall within the explosive range. The approximate explosive range, expressed as percent by volume in air, for the various more volatile hydrocarbons are: propane, 2.4-9.5; butane, 1.9-8.5; natural gas, 5.0-14.0; manufactured gas, 5.0-31.0; gasoline, 1.3 to 6.0. Metal heated to a temperature just below redness will not ignite butane or gasoline, but will ignite paper.

Dipole Moment of (Lubricating) Oils, R. HEINZE, M. MARDER, K. H. DORING AND K. BLECHSTEIN, *Oel u. Kohle* **37** (1941) pp. 8-23.

The authors review the hydrodynamic and polarity theories of lubrication. The dipole moments of several vegetable and mineral lubricating oils were calculated by the Debye method from measurements of their dielectric constants. The data are presented in tabular form. The dipole moments of fatty oils are higher than those of the hydrocarbon oils. In order to eliminate errors caused by association the dipole moments were determined in solutions of various concentrations. No association was observed in the case of the mineral oils, but association was pronounced in the vegetable oils. The dipole moments of mineral oils are improved by the addition of vegetable oils. The close relationship that exists between the value of the lubricant and dipole moment cannot yet be explained.

Chemical Compositions And Reactions

The Nitrogen Compounds in Petroleum Distillates. XXIII. The Structure of a $C_{16}H_{25}N$ Base from California Petroleum, B. SHIVE, S. M. ROBERTS, R. I. MAHAN AND J. R. BAILEY, *Jour. Amer. Chem. Soc.* **64** (1942) pp. 909-12.

In the Edeleanu kerosene extract from California petroleum a nitrogen base $C_{16}H_{25}N$ occurs in relatively large amounts. It was first isolated by Thompson and Bailey. It has been shown by the authors to be 2-(2,2,6-trimethylcyclohexyl)4,6-dimethylpyridine. A structural correlation of a naphthenic acid and a naphthenic base from petroleum has been established for the first time. The chemical procedures used in the work are described in some detail.

Preparation of Bivinyl by Catalytic Dehydrogenation of Butene, A. A. BALANDIN, N. D. ZELINSKII, O. K. BOGDANOVA AND A. P. SHCHEGLOVA, *J. Applied Chem.* (U.S.S.R.) **14** (1941) pp. 435-45 (in French, 445). Translation in *For. Petr. Tech.* **9** (1941) pp. 265-82.

The catalytic dehydrogenation of butene was effected in the presence of the following catalysts: Cr_2O_3, Cr_2O_3 on kieselguhr (25% by weight) Cr_2O_3 and 20 percent of a mineral closely related to zircon, Cr_2O_3 and CuO (10%), Cr_2O_3 and ZnO (9.1% by weight), Cr_2O_3 and MoO_3 (50 mol. %), V_2O_5 and Al_2O_3 (26.4% by weight of V_2O_5), the same obtained by joint precipitation of Ag_3VO_4 (33% by weight) on kieselguhr (67% by weight), and magnesium oxide. The reaction was effected at atmospheric pressure with contact time of 0.3 seconds. Butene was mixed with carbon dioxide in the ratio 1:7.5% by volume. At 600° C. the yield of butadiene was 34% based on the butene passed and 77% based on the butene decomposed. At 550° C. the yields were 27% based on butene passed and 82% based on butene decomposed. The other reaction products are hydrogen and carbon monoxide in equimolecular proportions with a slight amount of ethylene and saturated hydrocarbons.

The Preparation and Isolation of 4-Methyl-1,3-pentadiene, G. B. BACHMAN AND C. G. GOEBEL, *Jour. Amer. Chem. Soc.* **64** (1942) pp. 787-90.

A study has been made of the effect of solvents, temperature and catalysts on the reaction between maleic anhydride and the diene mixture resulting from the dehydration of 4-methyl-2,4-pentanediol. By a suitable choice of conditions it has been found possible to leave the 4-methyl-1,3-pentadiene in this mixture unreacted and to isolate it in a pure form in 23% yield. The boiling point, density and refractive index of this otherwise difficultly obtainable diene were carefully determined.

The Thermal Decomposition of Five-Membered Rings, F. O. RICE AND M. T. MURPHY, *Jour. Amer. Chem. Soc.* **64** (1942) pp. 896-99.

In a recent paper by one of the authors it was shown that cyclohexene decomposes quantitatively into 1,3-butadiene and ethylene. In an extension of this work to other ring systems a number of five-membered ring compounds were made and decomposed. Cyclopentadiene proved to be astonishingly stable and was not affected appreciably by conditions that cause extensive decomposition in all the other five-membered ring systems examined. Cyclopentene was decomposed to the extent of 95% into cyclopentadiene and hydrogen. Cyclopentane undergoes a more complicated decomposition. The main products were hydrogen, ethylene, propylene, cyclopentene, and cyclopentadiene. Decomposition of methylcyclopentane is still more complicated. About 40% decomposes into propylene. About 30% of the decomposition gives hydrogen and a mixture of cyclic mono- and diolefins. Several cyclic anhydrides were studied and were found to decompose quantitatively into carbon monoxide, carbon dioxide, and an unsaturated hydrocarbon.

High Polymeric Reactions, Their Theory and Practice, H. MARK AND R. RAFF, Interscience Publishers, Inc., 215 Fourth Ave., New York, N. Y. Price $6.50.

This is the third volume in a series on "High Polymers." The first part of the book considers the general and theoretical aspects of the structure, mode of formation and reactions of addition and condensation polymers. The second part discusses and summarizes the experimental data on the preparation and chemical properties of particular polymers of both types. The first part starts with a detailed discussion of theories of valency, and leads up to a definition of the bonds joining the units of high polymeric molecules. General methods available for the preparation of high polymers are discussed, as well as methods for the measurement of the rate of formation of polymers and for determination of their molecular weights. There is still considerable doubt as to whether the induction periods that have been observed for many polymerizations are not due entirely to the presence of traces of inhibitors or to the slow formation of a

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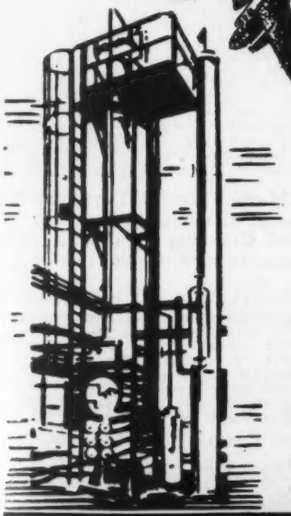

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catalyst, such as a peroxide, by the absorption of oxygen from the air. In the second part of the book data available in the literature concerning the preparation, chemical properties, structure and mechanism of formation of over one hundred and fifty individual addition polymers, as well as certain important condensation polymers, are reviewed. The organization of the material of the book is excellent and the subject is treated thoroughly and precisely. Over 1000 references to the original literature are included. The book will constitute a valuable addition to the literature of the subject, and will be valuable to anyone interested in the polymers, either from the theoretical standpoint or that of their preparation.

Conjugated Diolefins by Double Bond Displacement, A. L. HENNE AND A. TURK, *Jour. Amer. Chem. Soc.* **64** (1942) pp. 826-29.

A systematic study of the effect of various reagents and of various experimental conditions on the rearrangements of dimethallyl and diallyl was made. The displacement of the double bonds in diolefins was investigated. The diolefins dimethallyl and diallyl were studied first in order to determine sets of conditions that would promote isomerization, and to establish a standard procedure for use with other hydrocarbons. A series of 1,5-diolefins was then subjected to catalytic and alumina treatment, and the products separated, studied and identified. The nature of the isomerization reaction is discussed. The rearrangement of dimethallyl occurs more easily than that of diallyl. This same effect of a side chain methyl group was observed in the case of 1-octene and 2-methyl-1-heptene.

Manufacture: Processes And Plant

The Friction and Heat-Transmission Coefficients of Rough Pipes, W. F. COPE, *Inst. Mech. Engrs.* (London) J. & Proc. **145** (1941) pp. 99-105.

Cooling and friction data were taken on pipes of 3 degrees of artificial roughness. Although the pipe friction ran as much as 6 times as great for rough as for smooth pipes in the turbulent region, the heat transfer was little greater than for smooth pipes. At high velocities it was approximately 20 percent greater, at low velocities as much as 100 percent greater. The author concludes that for the same power loss, or even pressure drop, greater heat transfer is obtained from a smooth than from a rough pipe.

Nomographs for Minimum Reflux Ratio and Theoretical Plates for Separation of Binary Mixtures, E. H. SMOKER, *Ind. & Eng. Chem.* **34** (1942) pp. 509-10.

Distillation problems can frequently be simplified so that the separation to specified purities of only two components, having constant relative volatility and following Raoult's law, is necessary. Usually the first step in such problems is the fixing of the limiting conditions—namely, (1) the estimation of the minimum number of plates at infinite reflux, and (2) the estimation of the minimum reflux ratio at infinite plates. These can be computed from algebraic expressions. The author presents two types of nomographs for the determination of minimum reflux ratio and minimum theoretical plates for the separation of binary mixtures.

A New Method for the Determination of Equivalent Cracking Conditions for Commercial Cracking Reactions, S. L. NEPPE, *Jour. Inst. Petr.* **28** (1942) pp. 27-35.

A new method is presented for the correlation of equivalent cracking conditions of time and temperature during any commercial cracking operation. A chart is given showing that a straight-line relationship exists between the factor F for which velocity of cracking is doubled and the cracking temperature t. The relation can be expressed algebraically as $F_t = 0.04t - 10$. An equation

$$\frac{\theta_1}{\theta_2} = \left[\frac{0.04t_2 - 10}{0.04t_1 - 10}\right]^{17.22857}$$

in which θ_1 and θ_2 are the periods of cracking at temperatures t_1 and t_2 respectively. This equation very closely defines the relation between time of cracking and temperature for ordinary commercial cracking under constant pressure for a definite yield of product. A chart has been constructed that can be utilized in a simple manner for converting cracking conditions at any one temperature or period into equivalent cracking conditions

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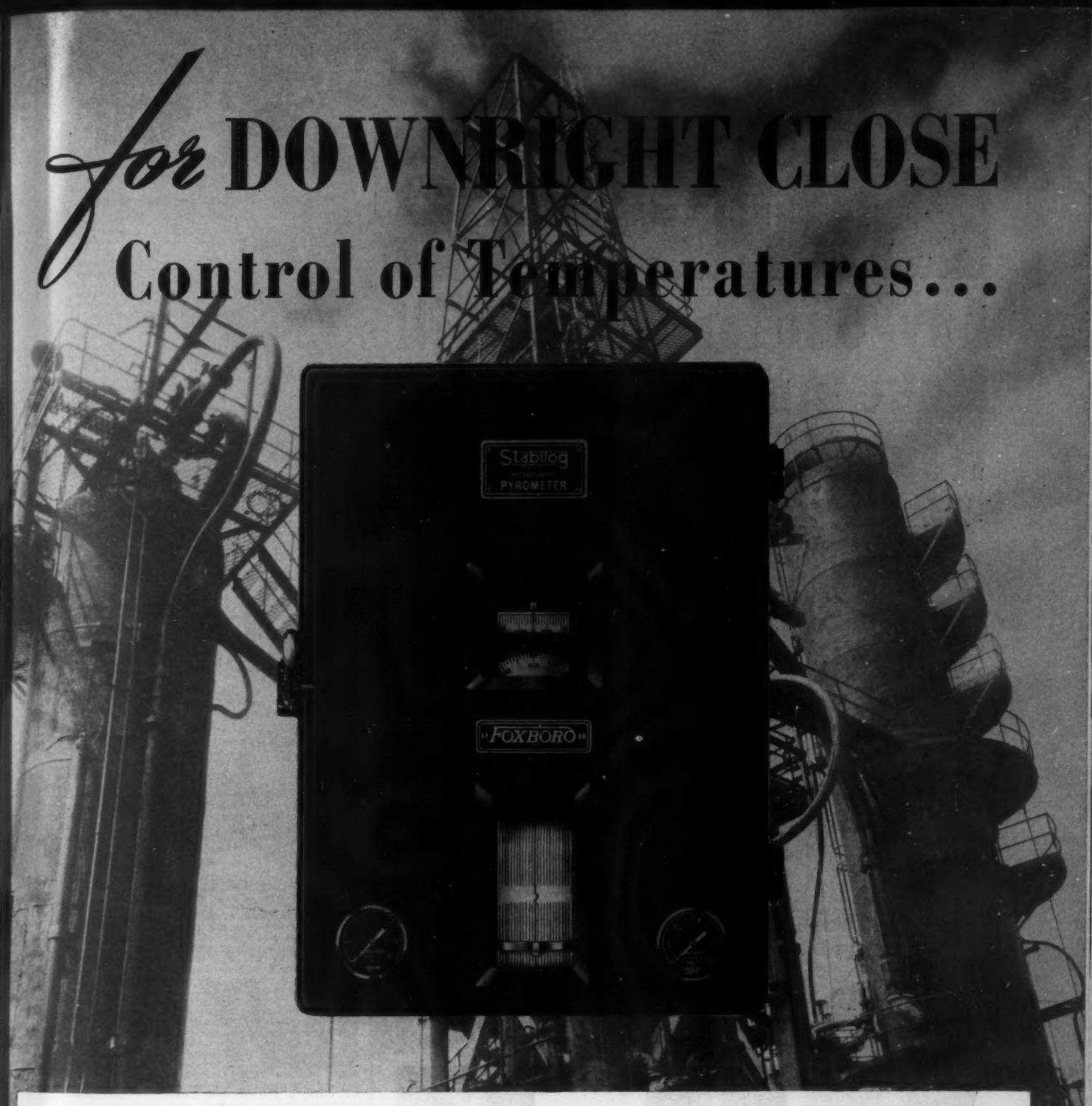

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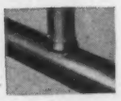

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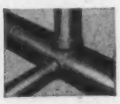

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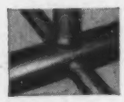

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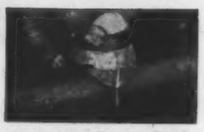
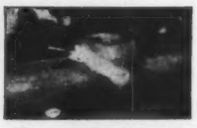


Mark center lines and tack the fittings into place.



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at any other specified temperature or period. The data presented in the tables, and curves of the article will be found most useful in the consideration of any problem of cracking rate.

Pyrogallol Derivatives as Gasoline Antioxidants, W. W. SCHEUMANN AND J. H. HASLAM, *Ind. & Eng. Chem.*, **34** (1942) pp. 485-8.

The antioxidant properties of various phenolic compounds have been extensively investigated in recent years, and many are being used successfully. In most operations the antioxidant is added to the gasoline immediately after it has been treated, at which time the gasoline often has suspended in it small particles of water in the form of a haze. This water settles in the storage tank, and if the antioxidant used is water soluble, a considerable proportion is extracted from the gasoline. The relative solubilities of antioxidants in water and gasoline are of great importance, therefore, and must be considered along with their inhibiting effectiveness. Pyragallol and its alkyl derivatives have found only a limited use as gasoline antioxidants because of the ease with which they are extracted from gasoline by water. 5-Alkylpyrogallol-1,3-dimethyl ethers in which the alkyl group contains 5 or more carbon atoms are more powerful antioxidants than the corresponding 5-alkylpyrogallols and also have more advantageous solubilities. The introduction of a second alkyl group to the ring of 5-methylpyrogallol-1,3-dimethyl ether resulted in a small improvement in antioxidant effectiveness, but the introduction of the third alkyl group gave a product with only slight antioxidant properties. The isolation of 5-methylpyrogallol-1,3-dimethyl ether and 5-propylpyragallol-1,3-dimethyl ether in pure form from hardwood distillate is described. These two compounds were responsible for a substantial part of the antioxidant properties of a hardwood distillate boiling at 217-310° C. In general, when the alkyl group contains 4 carbon atoms or less, the pyrogallol is the more effective inhibitor, but when the alkyl group contained over 4 carbon atoms, the 1,3-dimethyl ether is more effective. The 1,3-dimethyl ethers have more advantageous solubility characteristics than the corresponding pyrogallols.

Gasoline Intoxication, W. MACHLE, *J. Am. Med. Assoc.* **117** (1941) pp. 1965-71.

Gasoline varies greatly in composition, and correspondingly produces variable clinical symptoms. The pathological changes involved depend both on irritant and lipolytic activity. Changes in the blood chemistry are not significant. The relation between the components of gasoline and the effects of the gasoline is discussed, together with methods of diagnosis and treatment.

Lubricating Oil in 1941, W. MILLER, *Mining & Metallurgy* **23** (1942) p. 95.

Mention is made of the building of Duo-Sol process solvent-treating lubricating oil plants for the manufacture of aviation lubricating oils by the Standard Oil Company of California and by the Sun Oil Company. Sinclair has also built a new solvent-treating plant. Development work was active throughout 1941, following in general the line that lubricating oil will some day consist of a mineral oil base containing small quantities of chemical compounds specifically designed to meet the several requirements of satisfactory service. Few now question that solvent-treated oils used in internal combustion engines require corrosion-inhibiting addition agents, or that oiliness and detergent additives are needed for meeting the load-carrying demands of today's automotive gasoline and Diesel engines. Highly refined oils are subject to rapid oxidation in high-temperature service, and to formation of organic acids and other deleterious substances. Oxidation inhibitors are therefore required and also compounds to keep sludge suspended in the oil in order to prevent engine deposits. Several new types of additives were introduced commercially during 1941. One of the most successful and widely distributed is a compound having high anti-oxidant characteristics and other valuable properties. It is a sulfurized olefin produced synthetically from paraffin wax.

Phase Transition and Elastic Behavior of High Polymers, H. MARK, *Ind. & Eng. Chem.*, **34** (1942) pp. 449-54.

The subject of high polymers has become one of increasing importance in various phases of petroleum work. The use of butadiene and styrene derived from petroleum or natural gas raw materials further links the petroleum industry and the rubber industry and makes desirable a better understanding among petroleum technologists of the behavior of high polymers. The elastic behavior of high polymers is generally acknowledged to be rather composite in nature. In the case of rubber at least four different elementary processes probably combine to

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produce the actual behavior of the material. At very low stresses the van der Waals cohesion of the different segments in the curled-up chains is overcome, and the chains are brought into a more extended state. This type of elasticity was first emphasized by E. Mack. The kinetic elasticity of long-chain molecules is caused by the fact that the extended state is less probable than a state of intermediate curl. While the alignment of the chains takes place, molecular attraction between different chains causes crystallization. The crystallized phase has a certain amount of elasticity, characterized by a high elastic modulus. The author endeavors to coordinate these several elementary processes and proposes an explanation for the stress-strain curve of high polymers consisting of long-chain molecules.

Toluene in 1941 and '42, W. MILLER, *Mining & Metallurgy* **23** (1942) p. 97.

Estimates of toluene requirements have been increased frequently. The quantities now believed to be required for 1943 are 250 to 300 million gallons. In the last war all that was being produced at the peak was 10 to 12 million gallons per year. The synthetic toluene plant of the Humble Oil and Refining Company went into operation with an output above 27 million gallons per year. The Shell Company has two plants operating and one under construction for the extraction of toluene naturally present in small but recoverable concentrations in certain crude oils. The capacity of these three plants will be approximately 8 million gallons. Another plant is to be built that will have a capacity of 7 million gallons. A Knowles process coking plant for the destructive distillation of heavy petroleum residues will produce over 3 million gallons of benzol and over 540,000 gallons of toluene. The present rate of toluene production in the petroleum industry is estimated at 35 to 40 million gallons per year, and will probably surpass a rate of 60 million gallons by the end of 1942. This is approximately twice the present-day production of the coal-coking industry.

Stainless Steel Developments in Process Industries, G. A. SANDS, *Chem. & Met. Engr.* **49** (1942) pp. 88-91

The author considers the subject of stainless steel from the viewpoint of the large consumer, namely, the process industries. In the selection of material for a specific process the following factors must be considered: (1) time element; (2) first cost vs. equipment obsolescence; (3) service life; (4) effect of material on product, and (5) design and fabrication limits. Of these the time element, on account of competitive conditions in the production of various products, is frequently the most important factor. Stainless steel covers over 50 compositions that can be classified in accordance with their structural characteristics into three broad groups as martensitic, ferritic and austenitic steels. The present article is concerned with the martensitic and ferritic steels. A later article will discuss the chromium-nickel or austenitic steels. The martensitic steels are those containing from 12 to 14 percent of chromium, with 0.15 percent maximum carbon, and those containing 12 to 18 percent chromium containing 0.20 to 1.00 percent carbon. The low-carbon grade is extensively used as a clad veneer or lining for large vessels and columns in the petroleum industry to resist moderate corrosion conditions. The ferritic chromium steels are those containing from 15 to 30 percent chromium with a maximum carbon content of 0.15 percent. These steels show no significant transformation on quenching from a high temperature, and hence remain essentially ferritic at all temperatures. Actually, the steels of this group with less than 20 percent chromium contain a slight amount of high-temperature austenite and therefore harden slightly on cooling rapidly from a high temperature. The development of the 15 to 18 percent chromium steel made possible the production of synthetic nitric acid. The author traces the development of the commercial welding of the straight high chromium steels, which was begun in 1928, but on which little progress was made until about 1931. The standard nitric acid test for stainless steels is described. It consists in determining the loss in weight of a prepared specimen of stainless steel for each of five successive 28-hour periods in boiling 65 percent nitric acid. The loss in weight is converted by a factor to corrosion rate in inches penetration per month.

Standardizing Paints for Industrial Piping (Consolidated Report on Project No. 8), K. J. HOWE, ET AL. Official Digest Federation Paint & Varnish Clubs No. **212** (1942) pp. 9-12.

The project described was undertaken for the purpose of developing a standardized painting system for industrial piping, particularly for the identification of materials carried in the pipes. The New York-New Jersey Club suggested that fire protection

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equipment be painted red; dangerous material, yellow; safe products, green; protective materials, blue; and extra-valuable materials, purple. Suitable vehicles and extenders are given, as well as dry color combinations for each of the five colors for normal and for abnormal conditions of exposure.

Fighting Fires with Carbon Dioxide Gas, *Automotive Industries* **84** (1941) pp. 424-27.

Carbon dioxide is a good fire-extinguishing medium for use in plants that handle flammable liquids such as gasoline. It will snuff a fire in burning liquid flowing from a broken pipe connection. To extinguish flame by smothering, the content of oxygen in the gaseous mixture must be reduced from the normal 21 percent to 14 or 15 percent. There are two systems of fire protection by means of carbon dioxide. These are designated as the high-pressure and low-pressure systems. In the high-pressure system the carbon dioxide is stored in I.C.C. high-pressure vessels filled to approximately 68 percent of their total capacity. The pressure at 70° F. is 840 pounds per square inch. In the low-pressure system the carbon dioxide is stored in vessels or containers that are lighter in weight than the high-pressure vessels and that can be filled more completely, e.g., to 95 percent. A refrigeration system is provided in order to limit the pressure by keeping the temperature of the vessels within the limits determined. The Kidde system is typical of the high-pressure system, and the Cardox typical of the low-pressure system.

Products: Properties and Utilization

The Thinning of Varnish with Mineral Spirits, Philadelphia Paint & Varnish Production Club, Natl. Paint, Varnish Lacquer Assoc., Circ. No. **629** (1941) pp. 259-71.

Each of several varnishes was thinned in a special apparatus at 400-500° F. with paraffinic, naphthenic, aromatic and intermediate base solvents. Most of the commonly accepted tests for the evaluation of mineral spirits were shown to be misleading, paraffinic spirits tending to be underrated and naphthenic and aromatic spirits tending to be overrated. Paraffinic naphtha causes precipitation of some types of varnish but are quite satisfactory for thinning other varnishes such as those made from ester gum. The only certain way of determining the suitability of the solvent for thinning is to use the solvent in hot thinning. A possible systematic basis for the comparison of solvents is discussed.

Electrical Bitumens—Part II, E. E. Halls, *Ind. Chem.,* March (1942) pp. 76-8.

Electrical bitumens are broadly surveyed and their varied uses illustrated. Their applications are illustrated rather specifically but with typical and by no means exhaustive examples. It is stressed that there is a straight petroleum bitumen available to suit numerous purposes. By appropriate addition of waxes for modification the properties of the petroleum bitumen can be enhanced to render it suitable for many other uses.

The Detection and Determination of Diene Hydrocarbons with a Conjugated System of Double Bonds, I., V. I. Esafov, *J. Applied Chem.* (U.S.S.R.) **14** (1941) pp. 140-47 (in German, 147). Translated in *Foreign Petr. Tech.* **9** (1941) pp. 344-58.

The Kaufmann iodometric method for the determination of diene hydrocarbons with conjugated double bonds cannot be used in all instances. The excessively low values of the Kaufmann diene number are caused by side reactions and polymerization of dienes. Diene hydrocarbons can be distinguished from monoolefins by the generation of considerable amounts of HBr when brominating in a solution of CCl_4. The McIlliney method is suitable for the detection of dienes alone or in admixture with various hydrocarbons.

II. V. I. Esafov and A. V. Shpadi, *J. Applied Chem.* (U.S.S.R.) **14** (1941) pp. 148-50 (in German, 150). Translated in *Foreign Petr. Tech.* **9** (1941) pp. 359-63.

Bromination in carbon tetrachloride is specific for diene hydrocarbons with conjugated double bonds. The reaction is accompanied by the liberation of halogen acids. Hydrocarbons with separated double bonds are brominated like the olefins, with liberation of little halogen acid. The sensitivity limits of the bromination reaction for solutions of olefins with 1,3-dienes is 1 percent of the latter; for mixtures with saturated hydrocarbons the limit is 0.5 percent of dienes.

A Filtering Device for Viscosity Tubes, S. J. Hetzel, *Ind. & Eng. Chem.,* Anal. Ed. **14** (1942) p. 288.

The A.S.T.M. designation D-445-39T requires that the viscosity sample be filtered through sintered glass or through a fine wire screen into a small beaker or bottle. The author describes a filtering device that is more convenient and rapid as a means for ensuring an uncontaminated sample. It comprises a filtering cap made by sealing a sintered-glass disc 20 mm. in diameter and 2 mm. thick into a glass tube that is fitted to the viscometer pipet with a ground joint. With the cap in place the pipet is inverted and immersed in the beaker or wide-mouthed bottle containing the sample, and filled by suction in the usual manner.

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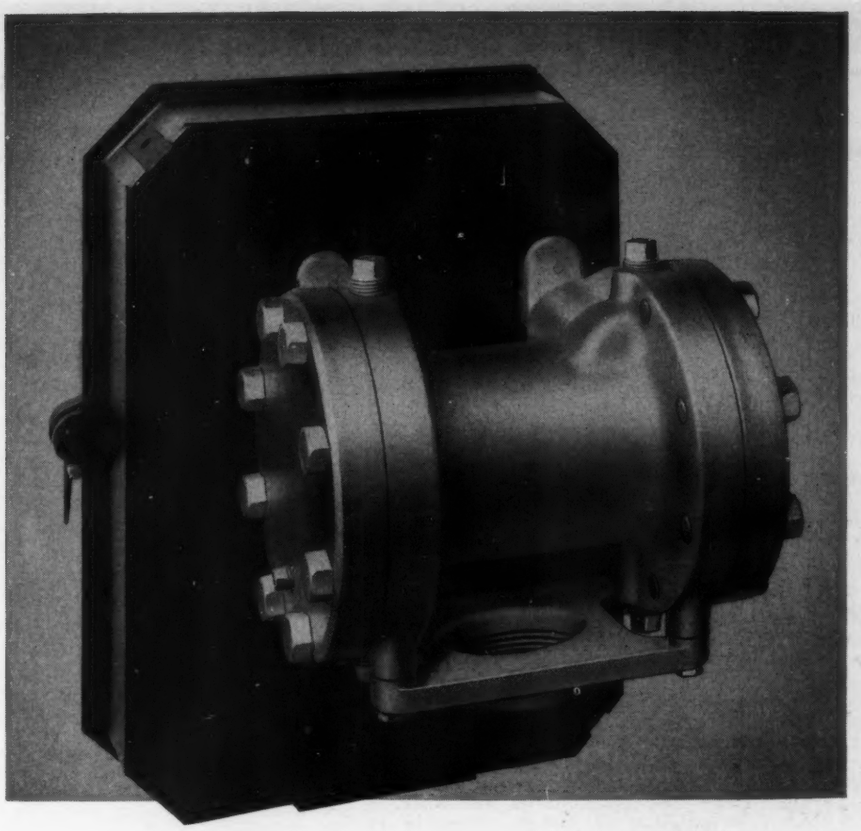

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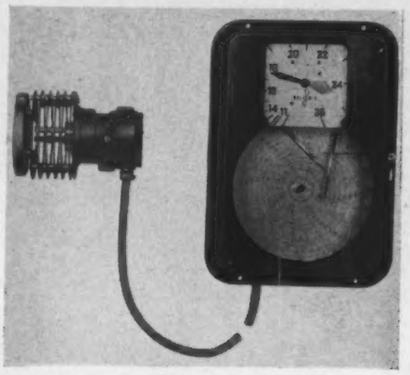
The Bristol Company, Waterbury, Connecticut, has introduced a new radiation pyrometer, designated Pyrovac.

This new instrument is designed for recording, indicating, or automatically controlling temperatures in furnaces above 900° F. The temperature-sensitive unit or radiation head is mounted on the outside of the furnace out of the hot zone where it picks up heat rays emitted from the object under measurement, thus registering its surface temperature.



Radiation Pyrometer

The Pyrovac Radiation Pyrometer is intended for use in measuring and automatically controlling temperatures that fall into the following classifications:

1. High temperatures out of the range of the thermocouple.
2. Temperatures for which rare-metal thermocouples are used.
3. Surface temperatures, such as roof, wall, duct, lining, or retort temperatures and the temperature of the work itself rather than furnace or kiln temperature surrounding the work.
4. Where object is moving, is inaccessible, or where there are space limitations.

Welding Aid

ACME WHITE LEAD AND COLOR WORKS

Acme White Lead and Color Works, Detroit, announces a new product, Quality Industrial Finish Flash-Off No. 99, which is used in welding to prevent spatter.

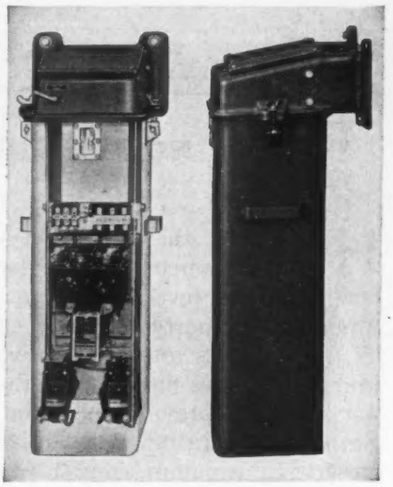
Use of the product is simple. The welder brushes, sprays or wipes the product along the edges of the metal surfaces to be joined by the weld. Then when the welding is done metal chips bounce or fall off instead of adhering to the surface.

An additional feature is its cleansing effect to the surface to which applied. It prevents pitting on galvanized or ungalvanized metal surfaces and permits immediate application of paint without cleaning operations other than wiping off.

Starters

SQUARE D COMPANY

The industrial Controller Division of the Square D Company, 4041 North Richards Street, Milwaukee, has announced an oil-immersed starter that incorporates design features facilitating installation, service, and operation. A sharp demand has been created due to greatly expanded activity in chemical plants, refineries, powder, and shell loading plants.



Square D Starter

Easier installation is provided through use of a cast head with a wiring manifold which permits conduit entrance from five directions. A removable cover plate facilitates the threading of bare wire through an insulating spacer above the oil bath. Many problems usually encountered in servicing oil-immersed equipment have been overcome. The welded seam tank is designed for a minimum quantity of oil. A large window-type oil-level gauge provides quick, clear visibility. The drain cock is recessed in the bottom. Track-type guides prevent swinging, splashing or accidental collision with the starter panel while the tank is being raised or lowered. Hooks at the bottom of the guide track support the tank in lowered position for

'BESTOLIFE

THE PERFECT LEAD SEAL

THREAD AND GASKET COMPOUND FOR ENGINES AND PUMPS

'BESTOLIFE Lead Seal Thread and Gasket Compound is saving time, labor and money in the Refining Industry every day. Here's why—

1. Prevents galling of pipe threads.
2. Assures quick and easy separation of parts.
3. Lengthens life of threads. Will not corrode.
4. Will not pile up. Not affected by vibration.
5. Increases packing life and prevents scoring.
6. Not affected by heat or cold.
7. ALWAYS FORMS A PERFECT SEAL.
8. Assures tightest joints.
9. Will withstand any necessary pressure conditions.
10. QUICKLY AVAILABLE FROM SUPPLY HOUSES EVERYWHERE.

USE 'BESTOLIFE

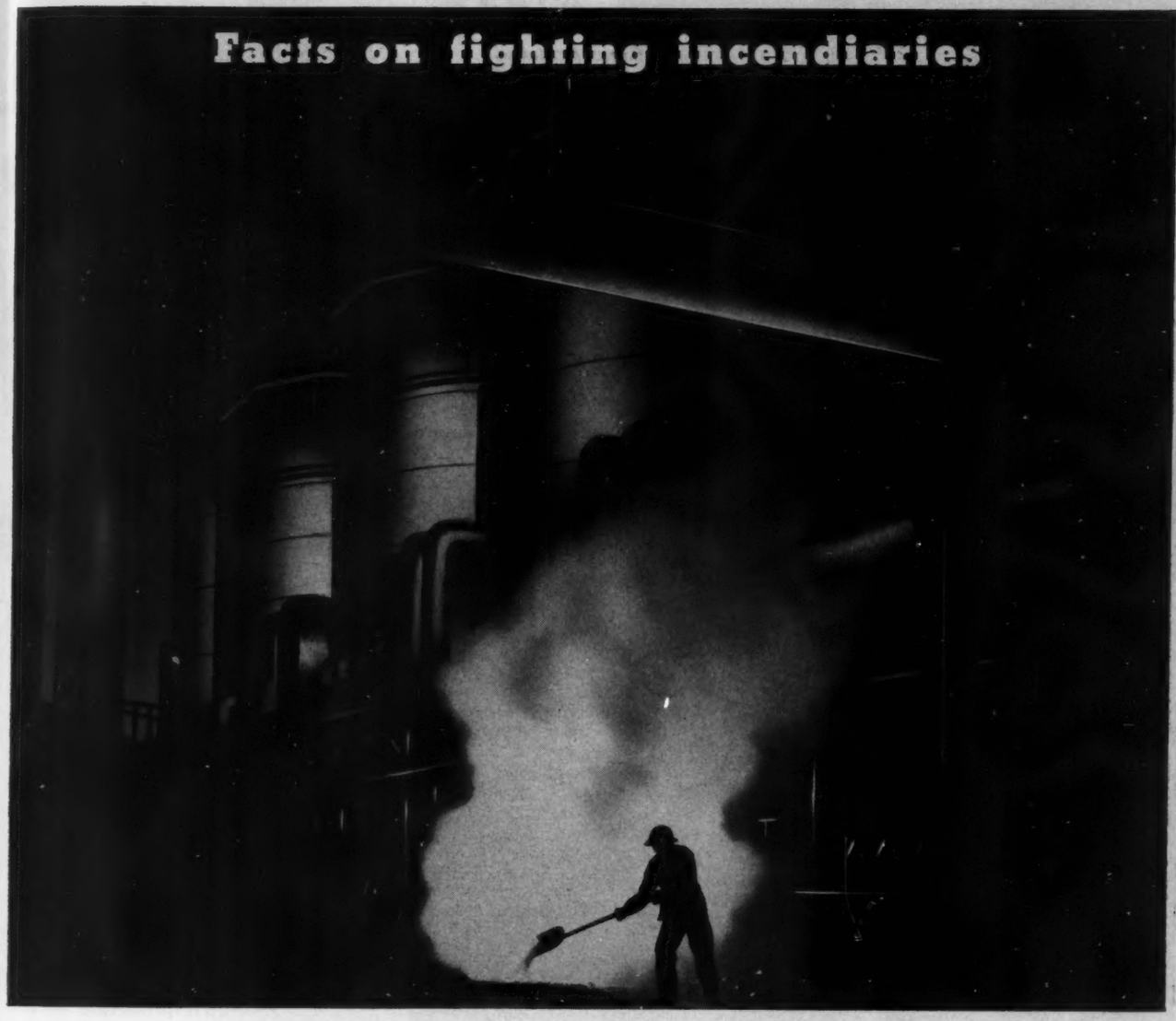
On Pipe Threads, Flanged Joints, Gaskets, Cylinder Heads, Tube Caps, Nuts, Studs, Tanks, Compressors, Boilers, Pumps, Fittings, Dynamos, Housings, Motors, Exhaust Lines or wherever a TIGHT JOINT IS NECESSARY.

MANUFACTURED EXCLUSIVELY BY

I. H. GRANCELL

2905 EAST FIRST STREET, LOS ANGELES, CALIFORNIA

Facts on fighting incendiaries



Information supplied by "Refiner and Natural Gasoline Manufacturer"

Incendiary bombs can fall upon plants and refineries at coastal points. Learn facts about fighting them.

The "intensive" type of bomb burns without scattering. Most usual kind is made of magnesium or magnesium-aluminum alloy. In the first minute or two, while the thermite igniting core is burning and shooting sparks 10 or 15 feet, approach bomb cautiously with sheet-iron shield or blanket when fighting fire around it. After thermite action is finished, the burning bomb may be extinguished. Heap on it such smothering agents as sand, ashes, common salt, or finely ground coal tar pitch. If bomb falls where it may burn without harm, burning may be hastened by turning on it a spray (not solid stream) of water, or foam.

The "scatter" variety of fire bomb has explosive charge which scatters combustible material, usually oil or phosphorus. Fight oil bombs like ordinary oil fires. Use water, foam or soda-acid to quench burning phosphorus particles. Rake up and remove the phosphorus while still wet, as it will ignite again when dry. Avoid touching it — and wash with 2 percent copper sulphate solution wherever it touches skin.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company
500 Fifth Avenue • New York City

MOLY

inspection. All starter parts are readily accessible.

For efficient operation, the magnetic overload relays are easily adjustable to meet prevailing conditions of application. Either hand or automatic reset relays are available. Removal of the tank from a combination starter automatically throws the breaker to "off" position.

Two kinds of oil-immersed enclosure construction are available: (1) corrosion resisting and (2) explosion resisting for class I, group D hazardous locations. Either kind can be furnished with any of the following four types of motor control equipment:

1. Class 8537 line voltage starters.
2. Class 8539 combination starters.
3. Class 8737 reversing starters.
4. Class 8810 two speed starters.

Non-Indicating Controller

C. J. TAGLIABUE MANUFACTURING COMPANY

C. J. Tagliabue Manufacturing Company, Park and Nostrand avenues, Brooklyn, has added a new non-indicating controller, which is suited to the majority of automatic control applications. It has been designed for compactness in such a fashion that the few parts are accessible with exceptional ease. The small size does not affect the interchangeability of the tube systems.

The smallest change of temperature at the bulb is transmitted positively and with great precision to the TAG Ball Air Valve through the novel transmitting spring lever that multiplies the movement of the powerful capsular spring.

Non-Indicating Controller

The air valve, in turn, resets the rate of flow through the diaphragm-actuated control valve in the steam line. In the TAG Number 42 the sensitiveness is high, the accuracy is permanent and the durability of the assembly has been proved by 24 years of service records.

Temperature and pressure models in a number of convenient ranges are available in this controller.

Burn Treatment

E. D. BULLARD & COMPANY

E. D. Bullard & Company, San Francisco, has added a spray treatment for burns, which applies a spray of tannic acid by pressing the valve on a dispenser bottle. The acid is fully prepared and needs no mixing prior to application.

This unit is one of the features of the new Bullard Emergency Burn Kit. Besides the tannic dispenser bottle, the kit contains castor oil for eye burns and a complete assortment of treatments and dressings. The units are packed in an attractive wooden case, natural finish, that is easy to open and that offers complete dust-proof protection to the dressings.

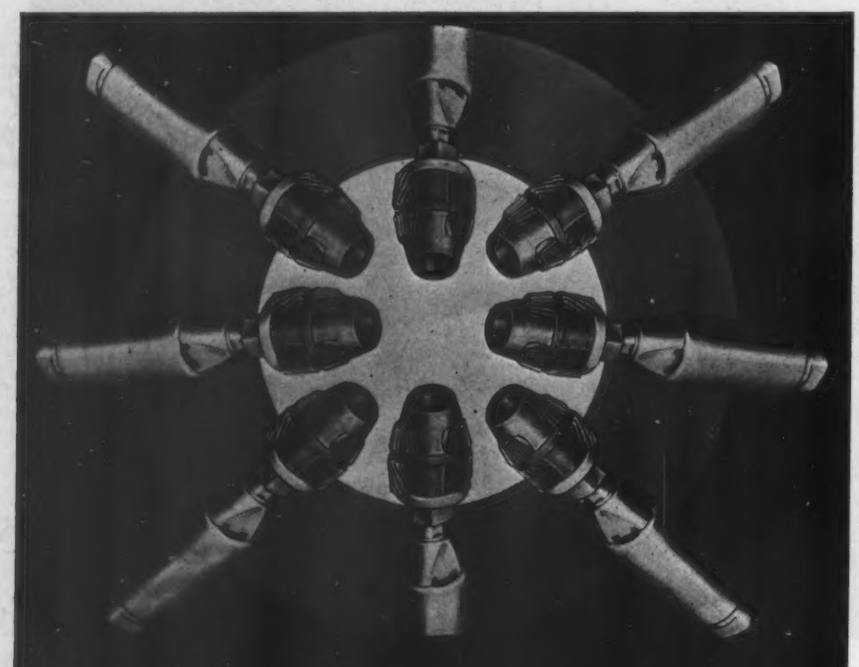
Step-Valve Pump

MILTON ROY PUMPS

Milton Roy Pumps, 1300 East Mermaid Avenue, Philadelphia, has announced an improved model plastics pump in which the step-valve and inlet and discharge connections are made from transparent plastics. This pump is recommended for handling alum solutions, hypochlorites, weak acids, mineral and animal oils and many other liquids, the "Plexiglas" valve being unaffected by most inorganic solutions and by alkalis and oxidizing acids only in high concentrations.

The pump is of typical step-valve design, with double-ball ground-glass checks and adjustable stroke for accurate control of volume from one quart per hour up to maximum capacity. Duplex models will handle up to 100 gallons per hour, Simplex models up to 50 gallons per hour against pressures as high as 150 pounds per square inch.

Single-piece cover plates for this plastics valve are readily removable without disturbing connections, and the manufacturer states that this valve is non-clogging, self-cleaning and eliminates all possibility of air-binding. The transparency of the plastic makes it possible to watch the pump function



WILSON "EP" TUBE CLEANERS REALLY INCREASE PRODUCTION

You *really* get *extra power*—from 30% to 75% *extra power*—delivered *to the tube wall*—when you use Wilson E P (Extra Power) Tube Cleaners; and you get this *extra power* with the use of from 25% to 40% *less air*. This means that you clean tubes *better, faster* and *more economically* and *reduce* down-time and *increase* production—vitally important factors to our all-out war effort.

A Wilson E P tube cleaning motor and the proper cutter head or other accessory quickly removes either soft, gummy, or exceptionally hard and heavy deposits from *any* refinery tube.

Write for the name of our representative nearest to you or send for a copy of our NEW forty page catalog fully describing and illustrating the complete line of Wilson tube cleaning equipment.

THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
47-28 37th Street Long Island City, N. Y.

CONSTRUCTION COMPLETED ON TIME!

To be sure your construction job is completed on schedule with all conditions met, choose a responsible contractor with a long record of successfully completed contracts.

This big recycling plant was completed by Zachry twelve weeks and one day after the ground was broken.

EXPERIENCED CONTRACTORS FOR:

REFINERY CONSTRUCTION • GASOLINE PLANTS • RECYCLING PLANTS • PRESSURE MAINTENANCE PLANTS • PIPE LINES • BUILDINGS • ROADS • BRIDGES

We are prepared to assume full responsibility for the satisfactory completion of construction jobs of *any size* either prime or sub-contracts.

OVER $20,000,000 in Army Air Bases successfully completed by Zachry since January. Work includes grading, sewers, water, electric systems, buildings, run-ways, and streets.

A large experienced staff of executives — used to handling large jobs *fast* gives the "know how" required to satisfactorily complete large contracts.

Ample financial backing eliminates delays due to financial trouble. We are prepared to assist in financing your plant if desired.

Able designers. Recognized engineers and architects are retained to design Zachry projects — assuring top efficiency of the completed plant.

● Your request for further information will be promptly answered. We shall be pleased to talk over your problems and furnish suggested designs and cost estimates.

TURN CONSTRUCTION WORRIES OVER TO US

THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA

SKILL, INTEGRITY and RESPONSIBILITY

H. B. ZACHRY COMPANY

General Contractors

SAN ANTONIO, TEXAS
HARDING BOULEVARD

HOUSTON, TEXAS
909 SECOND NATIONAL BANK BLDG.

LAREDO, TEXAS
2019 LINCOLN ST.

and to detect discoloration or dirt particles in the liquid as it passes through the valve.

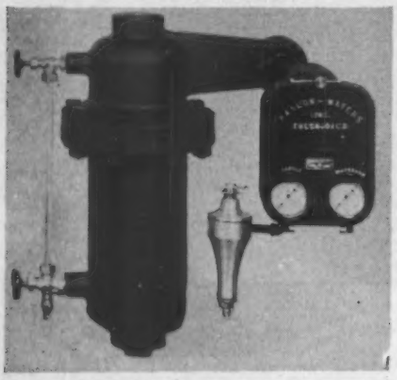
Cold Air Unit

NIAGARA BLOWER COMPANY

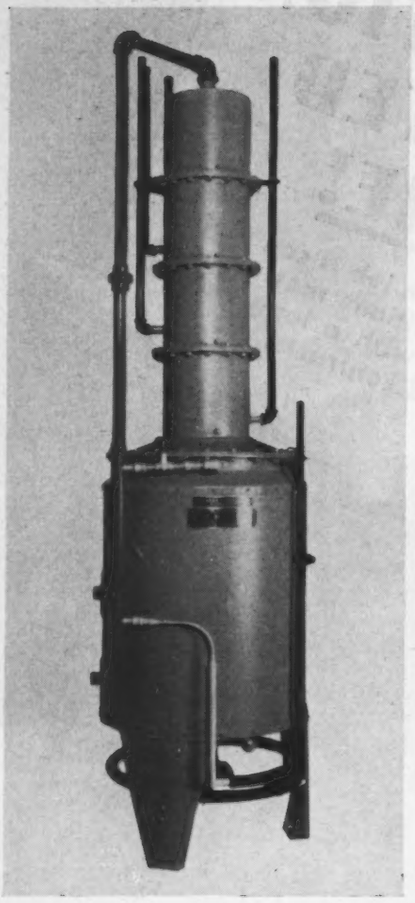
Niagara Blower Company, 6 East Forty-fifth Street, New York, has designed a unit for conditioning cold-air room conditioners at constant temperatures as low as minus 80° F. The units serve for experimental laboratories as well as for testing or normalizing parts, materials and machinery under these extreme temperature conditions.

This new equipment using Niagara No-Frost Liquid (no brine) gives constant operation without interruption or loss of capacity by reason of ice or frost forming on cooler coils or because of corrosion of the equipment from contact with brine or calcium. It consists of coolers operated in stages, the first stage reducing to temperature just above the freezing point of water and removing humidity; the second stage using the Niagara No-Frost Method to remove the balance of the moisture, and the third stage producing and holding the required final temperature.

Moisture is removed from the air below 32° F. without causing formation of ice on coolers by a method which employs a special non-freezing liquid continuously re-concentrated in a concentrator designed especially for this duty.



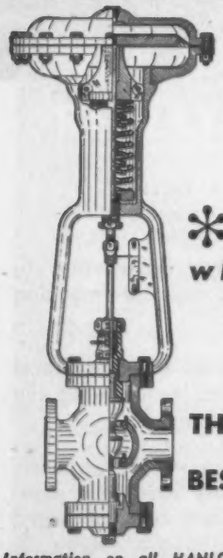
H-W Type 850 Level Controller



Niagara Cold Air Unit

• COMPANIONS •

FOR * Proven PERFORMANCE



H-W Type 86 Motor Valve

* Ask the men who operate them!

THEY ARE OUR BEST SALESMEN

Information on all HANLON-WATERS Equipment available at representative nearest you

HANLON-WATERS, INC.

TULSA, OKLAHOMA

New York, Chicago, Pittsburgh, Philadelphia, St. Louis, Denver; Shreveport and Lafayette, La.; Fort Worth, Houston, Corpus Christi, Longview and Odessa, Texas.

Corrosion Inhibitor

D. W. HAERING & COMPANY

D. W. Haering & Company, 205 West Wacker Drive, Chicago, announce development of a new corrosion inhibitor identified as ferri chrom glucosate. This new inhibitor is the ferric salt of quachrom glucosate and introduces a non-oxidizing chromium inhibitor for the first time. Ferri chrom glucosate controls corrosion in some applications in concentrations as low as two parts per million and may be employed in reducing equilibria and at low pH values for corrosion control.

Ferri chrom glucosate is a colloidal gel which may be used for film formation in process operations by dipping or spraying or may be incorporated in paints or lubricants for corrosion control.

Ferri chrom glucosate contains very little chromium and is non-irritating to handle. Its use for corrosion applications may reduce chromium consumption for this purpose as much as two decimals at the same time providing more effective control.

Controllers

C. J. TAGLIABUE MANUFACTURING COMPANY

C. J. Tagliabue Manufacturing Company, Park and Nostrand avenues, Brooklyn, announces a new line of temperature controllers, which are self-contained and self-operating.

TAG Self-Operating Controllers are used extensively on many different types of applications such as hot-water-storage heaters, hot-water-storage tanks and numerous other applications.

This controller uses no power outside

Steel VALVES!

Cast and Forged

Cast Iron VALVES —Standard and High Pressure

Every Type Used in an Oil Refinery

All Expertly Reconditioned and GUARANTEED to Perform Like New.

No Delays

Immediate Delivery

YOU SAVE 25% TO 40%

Over Cost of New Valves

For 8 years, a division of our plant has specialized in reconditioning valves for major oil companies and the U. S. Government. Our shops are equipped with the most modern and efficient tools and facilities for rebuilding valves. Every valve has been expertly reground, reseated, repacked and hydrostatically tested. GUARANTEED to give same service as new valves.

DON'T DELAY. Order your valve requirements NOW and save 25% and more! We can also make immediate shipment of reconditioned flanges — ells — tees — and other fittings at savings of from 25% to 40%. Order TODAY.

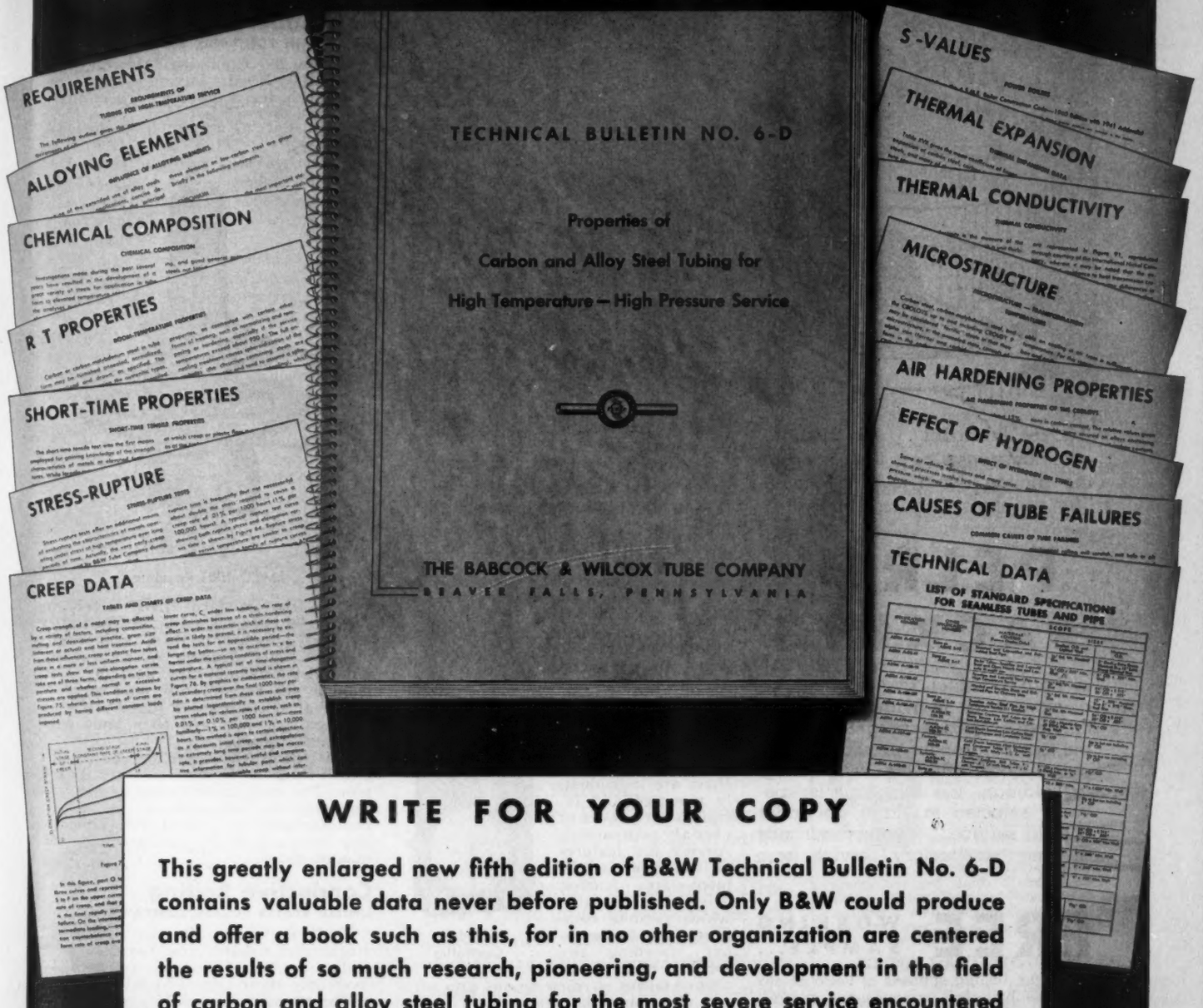
Brown-Strauss Corporation

1446 Guinotte . . . . . Kansas City, Mo.

HERE ARE THE ANSWERS

to your questions about high temperature – high pressure steel tubing

IN THIS NEW BOOK



WRITE FOR YOUR COPY

This greatly enlarged new fifth edition of B&W Technical Bulletin No. 6-D contains valuable data never before published. Only B&W could produce and offer a book such as this, for in no other organization are centered the results of so much research, pioneering, and development in the field of carbon and alloy steel tubing for the most severe service encountered in oil refining, steam generation, and kindred applications.

You will find this 157-page volume invaluable in choosing tubing of greatest utility and economy wherever temperature, pressure, and corrosion are severe. Your copy of this new book will be mailed to you promptly upon request on your company letterhead.

TA-1195

BABCOCK & WILCOX TUBES

HOT FINISHED COLD DRAWN ALLOY STEELS CARBON STEELS

THE BABCOCK & WILCOX TUBE COMPANY, BEAVER FALLS, PA.

It takes lubricant . . . a plentiful, continuing supply . . . to keep packing friction down to a minimum. The supply of lubricant in

PELRO* PACKING

is both plentiful and continuous, because **each individual strand** in this packing is impregnated with the lubricant under pressure, while hot, before braiding or twisting. In addition, the lubricant is specially selected to stand up under solvent service . . . your assurance of long, satisfactory service from PELRO.

FREE WORKING SAMPLE...

Prove the lasting softness of Pelro at our expense. Just send us your name and address, stating the service for the packing and its size, and a generous sample will be sent you without charge or obligation.

*Reg. U. S. Pat. Off.

GREENE, TWEED & COMPANY
Bronx Blvd. at 238th Street
New York N. Y.

PALMETTO
for steam, hot water, air.
PALCO for water. PELRO for oils. CUTNO for alkalis.
SUPERCUTNO for acids.
KLERO for foods, etc. PALMETTO SUPERSHEAT
PACKINGS

Self-Operating Controller

of the energy developed in its own system. The temperature changes at the sensitive element or bulb in the apparatus under regulation, raises or lowers the vapor pressure of the volatile liquid in the tube system. A capillary connecting tube transmits the pressure change to the power bellows. The bellows expand and contract in response to the temperature changes at the bulb, position the steam valve and so control the temperature.

Schedule Controller

TAYLOR INSTRUMENT COMPANIES

Taylor Instrument Companies, Rochester, New York, is offering the Taylor Fulscope Time Schedule Controller, an instrument designed for maintaining exact temperature, pressure, flow or liquid-level recording to a predetermined schedule. After the desired processing schedule has been fixed, it is possible to repeat the process as many times as desired.

Schedule Controller

The cam and the chart are individually mounted and located for instant visual comparison. Among the features of the new instrument are: friction drive cam assembly which permits rotation of the cam without loosening any locking means; improved means of resetting one cam without disturbing the other in an instrument with two complete control mechanisms; each cam capable of operating from one to four air valves, micro-switches or both for the actuation of any external mechanism such as a valve, bell or light, and do this automatically in any desired relation of one to the other; and the automatic return of the cam to the starting position.

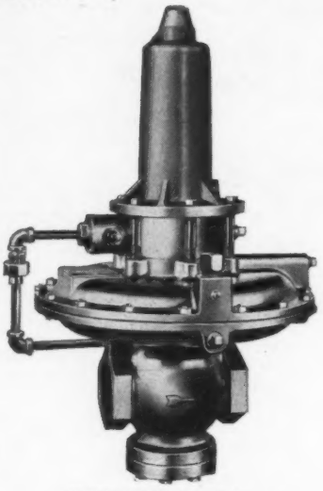
An optional feature is the interrupter timer which allows extreme flexibility to both the rise and the holding periods of the process under control. This timing feature allows the use of a very fast cam clock for a rapid rising period, but reduces the speed of the clock to increase the length of the holding period. The rising period, the holding period or both may be increased as much as 6½ times normal period. It is built right in the time schedule controller, eliminating need for a separate timing controller.

The new instrument is available in all control forms, including automatic reset and pre-act. By the addition of precalibrated assemblies it can be converted to fit any process requirements which might arise in the future.

Regulators

PITTSBURGH EQUITABLE METER COMPANY

Pittsburgh Equitable Meter Company, 400 North Lexington Avenue, Pittsburgh, has announced the addition of a high-pressure series to the present line of EMCO "1001" gas pressure regulators.



EMCO 1001 Regulator

As in the standard "1001" regulator, this model is furnished either for outlet or inlet pressure control. This high-pressure series regulator, which provides an outlet pressure range of up to 60 pounds per square inch maximum, is so designed as to cover the entire span between 5 pounds and 60 pounds with the same spring.

It is furnished in one size only with 2-inch threaded connection for standard pipe. The manufacturer states that this regulator can be used to control air, manufactured or natural gas. Descriptive literature can be obtained from the manufacturer.

Conductive Belting

UNITED STATES RUBBER COMPANY

United States Rubber Company, Rockefeller Center, New York, has perfected a rubber belting, designed to overcome static caused by friction.

The product was made possible by a discovery which turned rubber, originally an insulator, into a conductor. Thus in a product made from this substance static electricity which accumulates is harmlessly carried off.

Because of the low resistance of the material, however, there is no danger of an electrical connection from one transmission line to another should an accidental short circuit occur.

Two types of conveyor belts are supplied, one with a 2500- to 3000-pound long-wear conductive cover, and the other with a 1000-pound cover for less severe service.

Conductive V belts are also available for drives on fans handling explosive vapors or equipment in hazardous industries.

Goodyear Starts Synthetic Rubber Production

Synthetic rubber started flowing this week from a government-sponsored addition to The Goodyear Tire & Rubber Company's Chemigum plant in Akron as the firm advanced another step toward meeting the nation's war needs.

Officials of the company disclosed that the new addition with its annual capacity production of 15,000 tons probably will be in full operation within a short time, with additional facilities to provide another 15,000 tons annually scheduled for completion late this year.

As with Goodyear's privately-financed original plant completed last June, production from the two additions is confined exclusively to U. S. Army and Navy requirements.

Rising from abandoned farmlands which produced only mosquitoes a year ago, the additions supplement the plant which Goodyear inaugurated nearly a year ago to produce about 2,500 tons of synthetic rubber per year.

The additions are modelled after the original Chemigum structure which Goodyear erected—and utilizes the same processes. Prior to erecting the original Chemigum building, however, Goodyear had been producing synthetic rubber from a small pilot plant since November of 1940.

Construction of the first addition to the original Chemigum plant started last July with a $400,000 government grant, predicated on expanding the original plant's capacity by 10,000 tons annually. Soon another 5000 tons annually was authorized.

Before the first addition was completed, the government ordered expansion to still another 15,000 tons annually. It is this project which is expected to go into service about November.

Most of the synthetic rubber from the addition placed in operation this week will be devoted to tires for the army and navy, with some being used for oil-resistant engine fittings, gaskets and couplings.

Since the original Chemigum plant was placed in operation by Goodyear, practically all its output has been devoted to bullet-seal gasoline hose and tanks for airplanes.

From three separate production-line units within this addition will pour three separate streams of synthetic rubber. In other nearby Goodyear plants the transformation into completed products will be finished.

Each production-line unit within the addition contains its own reactors or pulverizers; its own coagulators and filters, and its own driers and compressing equipment.

Thus a stoppage for any reason in one of the production-line units will merely slow temporarily the flow of synthetic rubber from the plant without halting it completely.

The same system of production is planned for the addition to be placed in operation later this year.

With the new addition just completed, and with completion of the other addition later this year, about 350 more jobs will be provided at the Goodyear Chemigum plant.

FIRE AND HOW TO FIGHT IT!

PULL THE TRIGGER
KILL THE FIRE!

HERE it is! . . . the fastest-action, easiest-to-operate fire-killer that ever knocked down a blaze!

There's a pistol grip for one-handed action and for quick maneuverability. There's a trigger-control for fast, easy discharge. A finger's touch discharges the unit. Only Kidde has these sensible, simple features.

You can get Kidde trigger-control extinguishers with 2 or 4 lbs. of carbon dioxide capacity. Use them against flammable liquid or electrical fires. Hang Kidde units in laboratories and garages, near work benches and on your trucks. When fire strikes, Kidde snuffs it out fast in a flurry of carbon dioxide snow-and-gas. Just *aim . . . shoot . . . kill the blaze!*

Think this over: Newly-hired workers may not know how to handle some industrial-type extinguishers in emergency. *But anyone knows how to pull a trigger!*

"NO SMOKING" MEANS *NO SMOKING*

Courts are handing out stiff fines and jail sentences to workers who violate smoking rules in defense plants. Unions are cooperating, too. National Fire Protection Ass'n warns that restrictions should at all times be *reasonable*. Often safe areas may be designated as O.K. for smoking. Best rule is—insist on strict observance whenever safety is threatened.

RED MEANS DANGER

When fire breaks out, extinguishers must be ready for action. Built-in electrically operated Kidde Systems may be equipped with tell-tale panel to indicate if unit has been discharged or maliciously disabled. Panel has one green, one red light. *Green* light shows Kidde System "ready and waiting". *Red* means System has been released, must be recharged.

DO YOU LIKE STATISTICS?

N.F.P.A. reports fire loss for last 25 years totals *over $10-billion.* 1941 total is an estimated 5% increase over 1940. Ten-year trends are much more encouraging. In the period 1922-31 annual *average* loss was $506 million! During last 10 years we cut these figures to annual average of $284 million. *This wasted money buys 1100 medium bombers!*

Kidde
SNUFFS OUT FIRE

Kidde Walter Kidde & Company Incorporated
617 West Street Bloomfield, N. J.

For Example:

DE-SCALING WATER-COOLED EQUIPMENT SAFELY

Are you looking for methods that many refiners and producers are successfully utilizing to increase operating efficiency and keep "thumbs down" on maintenance costs? Then investigate what Oakite cleaning materials can do for you!

For example, by de-scaling Diesel cooling systems, water-cooled compressors, condensers, coolers and heat exchangers with Oakite Compound No. 32, you can definitely count on securing (1) greater safety, (2) time saved, (3) superior results, and (4) lower cost. Due to its vigorous yet SAFE scale-dissolving action, this specially designed material speedily removes lime-scale deposits to restore normal heat transfer. Method is easy . . . no dismantling of equipment required. NEW, FREE, 24-page manual gives details.

Save Time . . . Money ON THESE JOBS, TOO!

On other jobs, too, such as salvage cleaning, drum washing, paint stripping, steam cleaning, let Oakite materials save you time and money! Write today.

OAKITE PRODUCTS, INC.
508 THAMES STREET, NEW YORK, N. Y.
Representatives in All Principal Cities of the United States and Canada

OAKITE CERTIFIED CLEANING
MATERIALS · METHODS · SERVICE

☆ BUSINESS NOTES ☆

Geist Now President of Allis-Chalmers

Walter Geist has been elected president of Allis-Chalmers Manufacturing Company, Milwaukee. His election followed the resignation of W. C. Buchanan in April, at which time Geist was named executive vice president.

Geist has had all of his business career in the Allis-Chalmers organization, where he went to work when 16 years old as an errand boy in the sawmill engineering department. From that job he advanced as tracer, draftsman and designer to become engineer in charge of transmission when he was 31 years old.

In 1933 he was made general representative of the company and was in charge of the personnel of its district offices, all dealers, sales promotion and advertising. Six years later he was elected a vice president and given the executive vice presidency in April, 1942. He is a director of York Ice Machinery Corporation.

Schwanhausser to Worthington Board

Edwin J. Schwanhausser, Buffalo, a vice president of Worthington Pump and Machinery Corporation, has been elected to the board of directors to fill the vacancy caused by the death of Edward T. Fishwick. He has been a vice president since 1939 and a member of the Worthington organization since graduation from Stevens Institute of Technology in 1915. For 14 years he was at the Harrison works becoming assistant manager in 1927. Two years later he was named manager of the Buffalo works.

All other directors of the corporation were re-elected.

C. N. Barney Elected Worthington Official

Charles Neal Barney of Scarsdale, New York, has been elected a vice president of Worthington Pump and Machinery Corporation, Harrison, New Jersey. He has been connected with the organization since 1918 and has been treasurer since 1931.

N. H. Brodell with Copperweld Steel Company

N. H. Brodell has been appointed metallurgical sales engineer of Copperweld Steel Company, Warren, Ohio. Brodell is a graduate of Carnegie Institute of Technology and has been with Timken Roller Bearing Company, Pittsburgh Crucible Steel Corporation and United Alloy Corporation.

Edward V. Osberg Joins Wilmington Chemical

Edward V. Osberg has been elected a vice president of Wilmington Chemical Company, 10 East Fortieth Street, New York. He will have charge of sales and technical services.

Formica Insulation Opens Houston Office

Edward Clark, a factory-trained specialist of Formica Insulation Company, Cincinnati, has been named representative for the Southwest and will specialize in services to the oil industry. His headquarters are 5701 Jackson Street, Houston.

Carrier Forms War Products Committee

Carrier Corporation, Syracuse, New York, has formed a war products committee, which will coordinate all sales, engineering and manufacturing facilities and to further activities of the concern, now devoted 98.5 percent to war production. The activity was proposed by Cloud Wampler, executive vice president.

Donald French, a vice president, is chairman of the committee, with F. F. Hoyt, vice chairman, and W. D. Graham, secretary. Other members are H. L. Laube, development vice president, Earle D. Williams and C. V. Fenn. One member of the committee will be assigned to duty in Washington.

As part of the plan, the company conducted a week's training course for 40 engineers and construction superintendents called in from Branch offices throughout the country. This training is intended to give field men an intimate knowledge of the local plant facilities.

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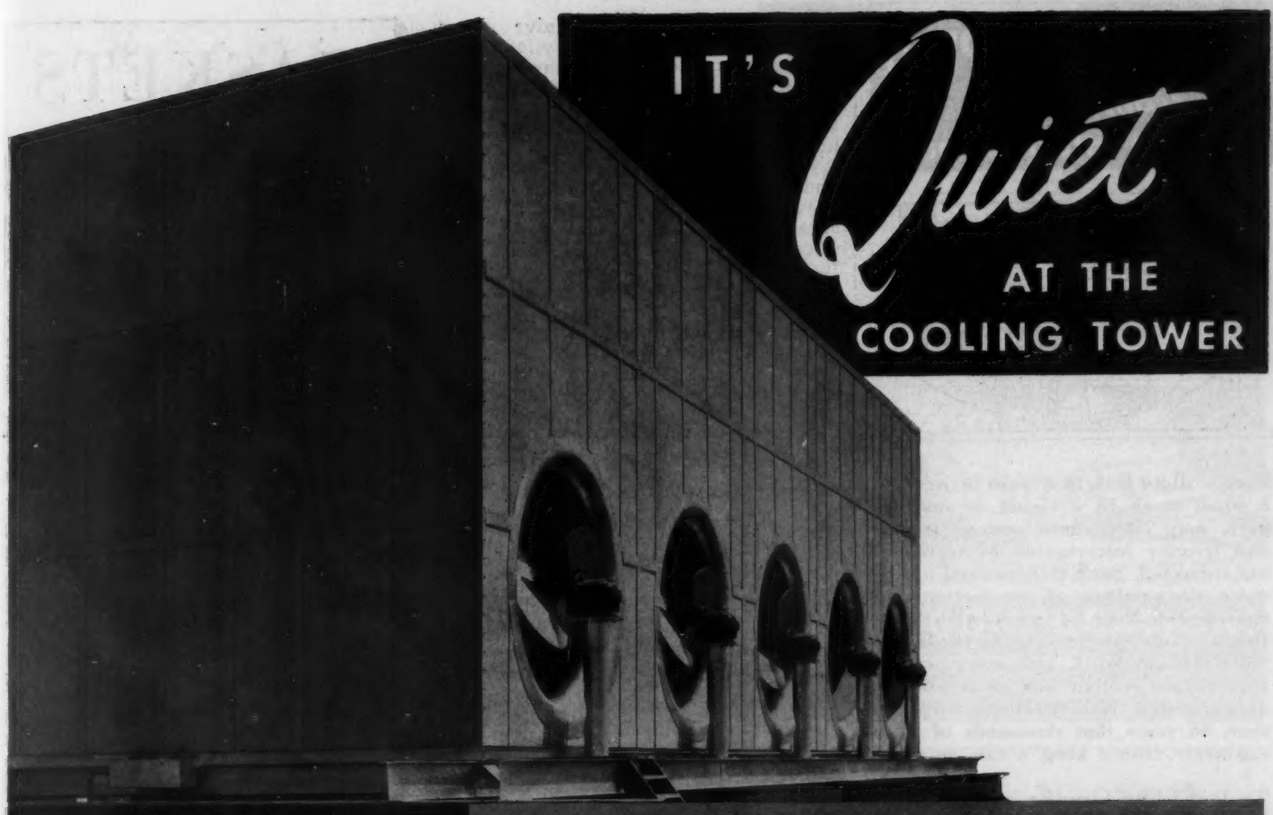

The Westinghouse Gearmotors that power the fans in this 3200-GPM mechanical-draft cooling tower, heart of the air conditioning system at New Orleans Municipal Auditorium, create less sound than the fans they drive.

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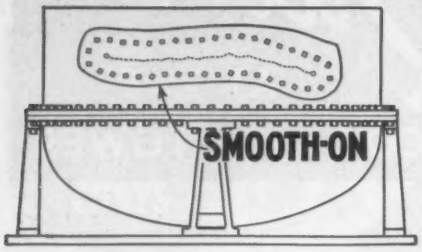

Even a slight leak in a seam or joint, or a small crack in a casing or machine part, may later cause serious trouble and lengthy interruption to service if not corrected. Such repairs need not require dismantling of equipment and considerable loss of production time. Instead, they can be speedily made with SMOOTH-ON No. 1. This many-purpose iron repair cement has so thoroughly demonstrated its helpfulness for more than 45 years that thousands of plant engineers always keep a can on hand.

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field will be enabled to give closer cooperation to Army, Navy and war industries and to obtain complete utilization of Carrier facilities for the manufacture of war equipment other than air conditioning, refrigeration and heating.

First of the training sessions opened under the chairmanship of E. T. Murphy, marketing vice president. Other speakers included Wampler, Donald French, vice president and chairman of the War Products Committee, and John H. Holton, works manager and vice president.

Following the first sessions, the field engineers and construction men are spending their time in various plant departments and in detailed examination of factory facilities and of the operations of various types of production machines.

Westinghouse Elects Four Vice Presidents

Four executives of Westinghouse Electric and Manufacturing Company, East Pittsburgh, have been elected vice presidents. They are Andrew H. Phelps, Pittsburgh, manager of purchases and traffic; L. E. Osborne, Philadelphia, manager of the steam division; Frank C. Reed, Jersey City, New Jersey, president of Westinghouse Electric Elevator Company, a subsidiary; Walter C. Evans, Baltimore, general manager of radio, x-ray and broadcasting divisions. All will continue in present executive positions.

Wheelco Instruments Opens Four Offices

Wheelco Instruments Company, Chicago, has named four new district representatives: V. E. Lindquist at the Iowa office in Des Moines and I. Solzman at Omaha, with Pasol Engineering Company as distributor for both states; Boyce Fitzgerland at Wichita, Kansas, with Fitzgerland, Inc., as the Kansas distributor; and Charles Drum as Texas district manager with headquarters at Houston.

Davis Goes to Buffalo for Copperweld Steel Company

F. B. Davis has been appointed manager of sales for Copperweld Steel Company in the Buffalo territory. His previous connection was with Edgar T. Ward Company.

Currier Is President of Tubular Association

Charles H. Currier, vice president of Ross Heater and Manufacturing Company, Buffalo, is the new president of

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By W. L. Nelson, Professor of Petroleum Refining, University of Tulsa; Consulting Petroleum and Chemical Engineer. 2nd Edition. 715 pages, 6 x 9, **106 tables, 201 illustrations** **$6.00**

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the Tubular Exchanger Association, 300 Madison Avenue, New York.

Other members of the organization are: Alco Products Division, American Locomotive Company; Foster Wheeler Corporation, Henry Vogt Machine Company, Griscom-Russell Company, The Lummus Company, M. W. Kellogg Company, Struthers-Wells Manufacturing Company, and Whitlock Manufacturing Company.

Mathieson Commemorates Fiftieth Anniversary

As part of the commemoration of its fiftieth anniversary, Mathieson Alkali Works, Inc., 60 East Forty-second Street, New York, has published a 48-page book, "Fifty Years of Chemical Progress," which is available to technologists within the petroleum industry.

The booklet traces the growth of the Mathieson organization and describes the company's major developments, which include the introduction of liquid chlorine and synthetic ammonia, the preparation of new chlorine carriers, bleaching agents, and detergents, and the production of alkalis of an exceptionally high degree of purity. Numerous illustrations show the scope of the company's present operations.

William B. Willson, Roto Western Manager Dies

William B. Willson, East St. Louis, Illinois, who represented The Roto Company, Newark, New Jersey, for 28 years as its western sales manager, died suddenly May 8. He was 64 years old.

William C. Johnson Heads Allis-Chalmers Sales

William C. Johnson, who has been sales manager of the crush and cement division of Allis Chalmers Manufacturing Company, Milwaukee, has been named manager of its general sales organization. The position was held until recently by Walter Geist, who has been elected president of the company.

Johnson will direct the sales of 1600 products, which are distributed through 60 district offices.

Cooper-Bessemer to Enlarge Plant Space

The Cooper-Bessemer Corporation, Mt. Vernon, Illinois, has begun additions of buildings and equipment, which will double its output of Diesel engines. The leading part of the construction consists of two new buildings, which will be used for storage and thus permit engines to be made in space now used for storage. Another structure will double the plant's pattern storing facilities.

The project is being financed under a plant facilities contract authorized by the Bureau of Ships, Navy Department.

Allegheny Ludlum Has New Department

Allegheny Ludlum Steel Corporation has created a flat rolled products department, which will be combined with the electrical and carbon steels of its manufacture. W. J. Adamson, former manager of carbon steel sales, has been named manager of the enlarged department. H. F. Porter has been appointed assistant manager of the electrical materials division.

The company has named W. R. Kuhn as manager of the Cleveland district, where he has been assistant manager since 1936.

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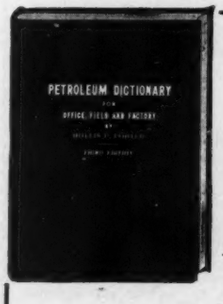

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CATALOGS ☆ BULLETINS

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Precision Instruments

Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia, has issued a publication of general interest to engineers, research scientists, executives and users of electrical instruments, controls and furnaces. It contains news of L&N instruments, controls and heat-treating methods, and of the jobs they are doing in industry, in research laboratories and in teaching and testing. It supplements the regular catalogs, bulletins and circulars which will continue to be issued as before. "Modern Precision" has 16 pages, 10½ inches by 15¾ inches. It contains valuable information for a wide variety of industrial, educational and scientific fields.

Pumping Control

The Foxboro Company, Foxboro, Massachusetts, has published Bulletin B-294 describing Rotax electric-operated control as employed in pumping applications. Rotax controllers of the recording and indicating type are shown, together with specimen chart records and installation photos. The text is largely devoted to water-works and sewage engineering but also covers pumping applications which are common in various industrial fields. Schematic diagrams of typical pumping installations are given.

Motor Maintenance

Wilkening Manufacturing Company, Philadelphia, has issued a 60-page manual on motor reconditioning, called the Pedrick Service Manual. It offers a practical discussion and guide to the accepted practices in general motor maintenance with special emphasis on piston-ring installation. It is illustrated with photographs, drawings and charts.

Hot-Weather Needs

E. D. Bullard Company, 275 Eighth Street, San Francisco, has compiled a pamphlet which outlines the benefits of certain hot-weather needs for workers, such as salt tablets, sponge sweat pads, snake-bite treatment and remedies for poison-oak and ivy poisoning.

Controllers

C. J. Tagliabue Manufacturing Company, Park and Nostrand Avenues, Brooklyn, has a new controller catalog, No. 900E, which describes the complete line of TAG non-indicating temperature and pressure controllers. Among the instruments are two new items, TAG No. 42, a controller which has wide applications and a self-operating controller which is used where compressed air or electricity are not available.

Vacuum

F. J. Stokes Machine Company, Tavor Road, Olney post office, Philadelphia, has a revised edition of the Stokes Vacuum Pump Catalog and Handbook on High-Vacuum Practice.

High-vacuum practice in evacuating tubes and bottles, in drying and impregnating cable, capacitors, loading coils, in processing chemicals and foods and in various other applications are discussed. Auxiliary equipment and its use, importance of oil, how to select pumps, how to detect and remedy leaks in a vacuum system and other important subjects are treated. Much technical data, charts and graphs, conversion tables and tables of boiling points of solvents at various pressures are included.

Pressure Gauge

The Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia, has published Bulletin 70-11, which is devoted to its new absolute pressure gauge. The instrument is designed to meet the requirements of processing where the pressures are so low as to be affected by variation in barometric pressure.

Safety Equipment

Mine Safety Appliances Company, Braddock and Meade Streets, Pittsburgh, has compiled Bulletin G-5, which describes the complete range of safety equipment needed during war emergencies.

Oil Burning

Peabody Engineering Corporation, 580 Fifth Avenue, New York, has issued Bulletin 107, which explains the operation of its constant differential wide range burning system. It provides a positive and flexible control of combustion over a wide range of capacity in excess of 50 to 1.

Furnace Door

Plibrico Jointless Firebrick Company, 1800 Kingsbury Street, Chicago, has a special bulletin which gives all construction details of its new furnace door for inspection and clean-out purposes.

Schedule Controller

Taylor Instrument Companies, Rochester, New York, has Bulletin 99111, which gives all details of its new controller, which can be adapted to repeating a processing schedule after the cycle of operation has been determined.

Pyrometers

The Bristol Company, Waterbury, Connecticut, has published Bulletin P1102, which describes its new line of Pyrovac radiation pyrometers. The folder gives the theory of operation and information regarding the use of radiation pyrometers. It is liberally illustrated with engineering drawings showing methods of use.

Insulation

Baldwin-Hill Company, 567 Klagg Avenue, Trenton, New Jersey, has a catalog of its several types of insulation for industry. The several types are set forth in detailed specifications as to heat applications as well as to methods of installation.

Regulators

Sarco Company, Inc., 475 Fifth Avenue, New York, has issued a new catalog, No. 600, which gives details of its line of self-operated temperature regulators for water heaters and industrial process applications. Each type is illustrated and a typical application if offered in a line drawing.

Metal Application

Metallizing Engineering Company, Inc., Long Island City, New York, has a 16-page Bulletin 42A, which describes the metallizing process and the equipment for its application. The book shows how essential industries are eliminating replacements and increasing service life of equipment by building up worn diameters and sprayed metal.

Oil Purifier

Sharples Corporation, 2300 Westmoreland Street, Philadelphia, has compiled a bulletin which describes its "En Bloc Oil Purifier," which is designed for Diesel engine, turbine or lubricating-oil purification. The unit consists of a fully enclosed super centrifuge mounted on the same base with two direct-driven gear pumps. Its design and constructions are presented in both illustrations and text.

Valves

Everlasting Valve Company, 49 Fisk Street, Jersey City, New Jersey, has published bulletin E-100, which gives full engineering information on its line of quick-operating valves for blow off, water columns and other boiler-room services.

The concise text is topically arranged for quick reference and explains the features of the unique valve designs. Complete tables of specifications, dimensions are included.

Building Material

Johns-Manville, 20 East Fortieth Street, New York, has published an illustrated folder which presents the uses of Transite movable walls for the quick provision of additional space in offices and buildings. The folder, Form TR-29A, shows how complete construction of finished new offices have been completed overnight.

Forged Products

Lenape Hydraulic Pressing and Forging Company, Box 4015, West Chester, Pennsylvania, has compiled complete engineering data on its Red Man welding necks, nozzles, elliptical handholes and manholes as well as other forged specialties. These products are used extensively in the fabrication of refining and chemical plants.

The catalog has been prepared as a reference manual to cover all standard and many special applications. It is extensively illustrated with both photographs and drawings. Specifications are given in tabular form. Eight pages of useful engineering tables are included.

Refractories

Mexico Refractories Company, Mexico, Missouri, has compiled a brochure, "Selecting of Refractories to Meet Specific Service Conditions," which is offered as a means of assisting users of such products in selecting the product that will serve under given conditions. A chart has been included, which sets forth the causes of refractory failures along with the particular property of a refractory necessary to counteract the condition.

Instruments

The Brown Instrument Company, Philadelphia, has issued a revised catalog on Brown Potentiometer Pyrometers, No. 1105. It presents clear and concise information on the design and operating features of the Brown Potentiometer Pyrometer and accessory equipment.

Temperature measurement by the radiation method is featured with a description and cross section view of the Brown Radiamatic Sighting Tube. A comprehensive line of installation accessories for practically all applications are illustrated.

Automatic control systems are described and their operation explained. Numerous Potentiometer Controller Models and control devices are illustrated and supplemented by detailed specifications.

Low Temperature Welding

Eutectic Welding Alloys, Inc., 40 Worth Street, New York, has compiled a bulletin on low-temperature welding with Castolin Eutectic Alloys. The process consists of applying with an acetylene torch especially adapted alloy rods at low temperature, below fusion. The alloys closely match parent metal.

Pipe Tools

Beaver Pipe Tools, Warren, Ohio, has issued a 28-page 1942 catalog, together with a 4-page condensed catalog.

The general catalog covers the complete line of portable pipe and bolt cutting and threading machines; portable pipe and bolt cutting and threading power drives and power units; pipe cutting and threading tools, ⅛- to 12-inch; pipe reamers; vises; sawing vises; grooving and beveling tools and threading oil. The book is completely illustrated and detailed information concerning each item in the line is given.

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